POWER PLANT ENGINEERING

Established Over 31 Years

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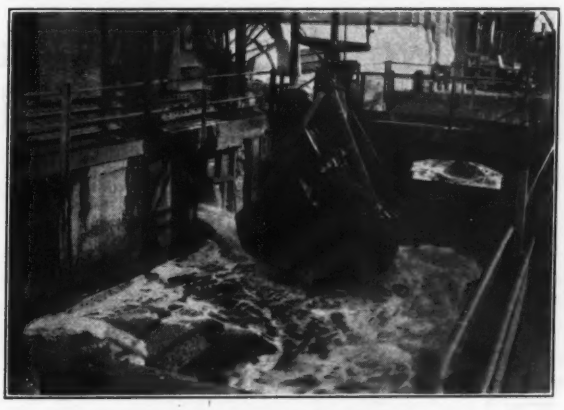


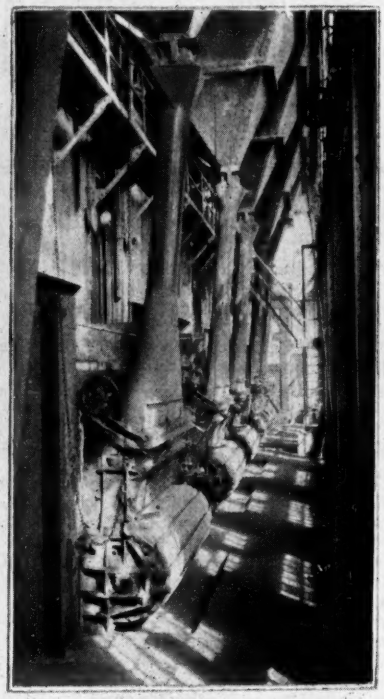
Ash Soup! Comin' Up!

WE VENTURE to say that you have often heard various noble descendants of Demosthenes and Pericles, when serving you with nourishment in the Hellenic establishments of gustatorial gratification scattered over the country, bawl through the kitchen such remarks as "Bin zoop!—Hemin ecks! Comin' oop!—Bottered tosst!" (our trusty fountain pen shudders in attempting to reproduce the accent).

But no descendant of the ancient Hellenes ever ordered up such a bowl of soup as is shown "comin' up" in the photograph. This soup, however, is familiar to any power plant engineer who uses a sluicing system to get his ash out of the plant.

It is quite simple to make; all one has to do is to add ash to water. No cooking is required. We understand also that ash soup is very filling and have seen cases in which it has been used for that purpose. After it is once made, however, it should be removed from the power plant as soon as possible.

In the above photograph is shown the sump into which the ash is sluiced from beneath 24 boilers in the Hell Gate Station. It is taken out of the sump by the bucket and placed in the hoppers at the left, from which trucks can be loaded for final disposal or it can be loaded into barges at the right and dumped at sea. Complete details of this ash sluicing system, together with data on the ash sluicing methods used by several other power plants, are given elsewhere in this issue.



Two Modern Railway Shop Power Plants

SANTA FE RAILWAY SYSTEM BUILDS TWO MODERN POWER HOUSES IN CONNECTION WITH NEW LOCOMOTIVE REPAIR SHOPS, GENERATING ELECTRIC POWER AT ONE AND PURCHASING IT AT THE OTHER

DURING RECENT YEARS railway companies have interested themselves in promoting efficiencies of operation, particularly in the manner of economizing fuel both for locomotives and shop power plants, so the newer railway power plants, both in design and in operating efficiency, compare favorably with many central station plants. This is exemplified in two modern power plants put into service by the Atchison, Topeka & Santa Fe Railway Co. in connection with their repair shop facilities at Albuquerque, N. M., and at San Bernardino, Calif.

ALBUQUERQUE POWER PLANT

Construction of the new shops necessitated a remodeling and enlarging of the old power house, a one-story brick building with a wooden roof housing four hand-fired water-tube boilers, turbo-generators of 500 kv.a. and 375 kv.a. capacity and two air compressors of 1500 and 2000 cu. ft. per min. displacement, respectively. The engine room was extended about 57 ft. and additions made for switchboard and pump room. The old boiler room was removed and replaced with steel and concrete building, which permitted the installation of stoker fired boilers with modern coal and ash handling equipment.

REVERSIBLE MOTOR GENERATOR USED TO REDUCE MAINTENANCE ON LARGE GENERATORS

Both alternating current and direct current are used in the shop. The total connected direct current load amounts to 2700 hp. and is supplied by two Universal Unaflow engines direct connected to two 250-v., 500-kw. General Electric generators and is distributed to the shop at this voltage.

Alternating current generators from the old plant generating current at 2200 v., 3 phase, 60 cycle were

FIG. 1. ALTERNATING CURRENT, DIRECT CURRENT AND COMPRESSED AIR ARE SUPPLIED TO THE SHOPS

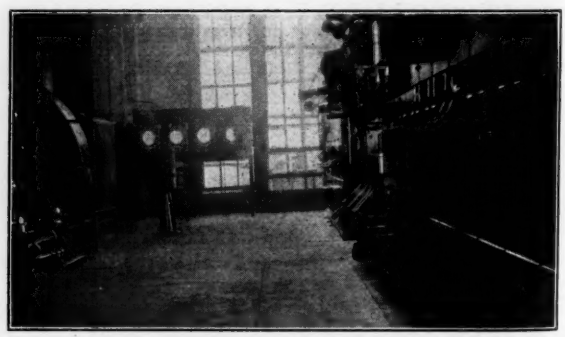


FIG. 2. SWITCHBOARD AT ALBUQUERQUE WITH THE FLOW METER PANEL IN THE BACKGROUND

retained but the voltage is stepped down to 440 v. before entering buildings. Practically all of the direct-current load occurs during the day, while the alternating-current load reaches its peak during the night. Therefore, a reversible motor generator set of 500 kw. capacity has been installed, and operates nearly 24 hr. a day, supplying the small amount of the direct current required for the machines at night and during the day the comparatively small amount of alternating current required for the lights.

Compressors Exhaust to Turbo-Generator Condensers

All of the units are furnished with steam at 160 lb. pressure, 100 deg. superheat. During the heating season part or all of the exhaust steam is used for heating. Two 825-sq. ft. Worthington surface condensers are installed under the turbo generators and interconnected with the exhaust of the generating units so that it is also possible to operate them condensing. One additional air compressor with Corliss steam valve gear was installed. This with the two old compressors gives a total compressor displacement of 7000 cu. ft. per min. Two of the compressors are also connected with the surface condensers under the turbo generators.

In the boiler room the four old boilers were removed and sent to San Bernardino and in their place five 500-hp. Stirling boilers were installed with space left for an additional unit. Boilers are set high and are fired with Coxe chain grate stokers. Forced draft is furnished by two 75-hp. motor driven Buffalo fans through concrete ducts. A breeching over top of boilers leads to a concrete chimney 230 ft. high and 12 ft. inside diameter.

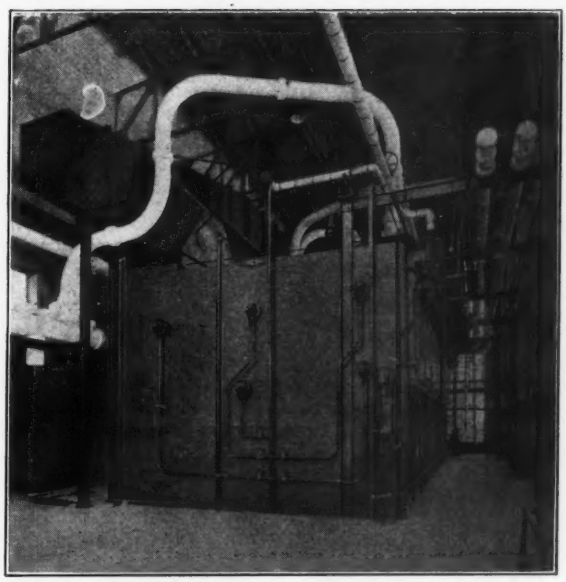


FIG. 4. ALTHOUGH OIL IS BURNED AT SAN BERNARDINO PROVISION HAS BEEN MADE TO BURN COAL IF NECESSARY

Feed water is supplied from a Webster open feed-

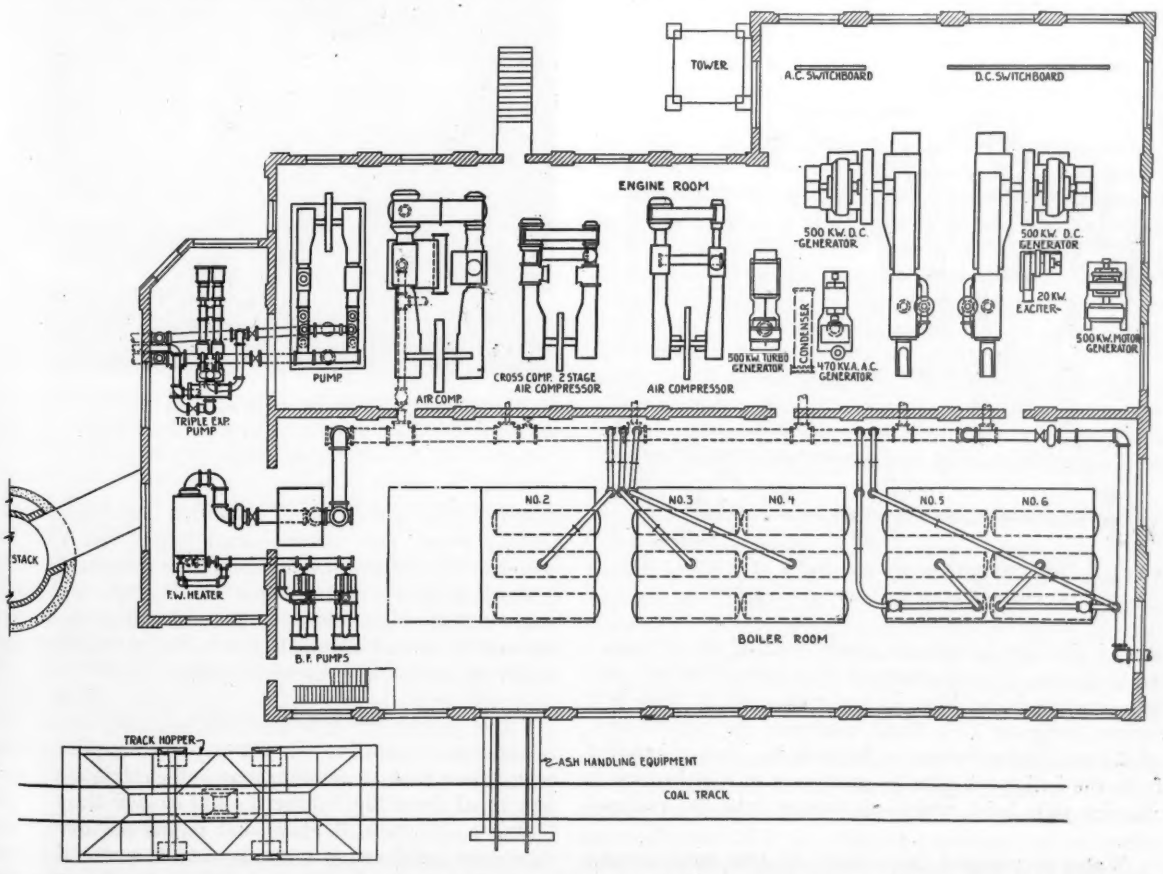


FIG. 3. NEW EQUIPMENT WAS ADDED AND THE OLD MACHINES RELOCATED TO GIVE A CONVENIENT ARRANGEMENT

water heater by two Worthington steam driven reciprocating feed pumps. Condensate from the condensers and heating mains is returned to a makeup tank located above the feed-water heater.

Western Anthracite Culm Used for Fuel

The fuel burned is unusual. It is anthracite culm from Madrid, N. M., about 40 mi. north of Albuquerque,

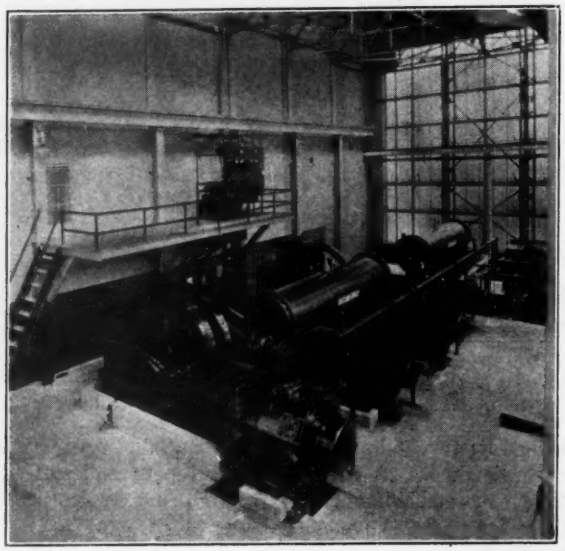


FIG. 5. IN THE SAN BERNARDINO PLANT THE SWITCHBOARD IS LOCATED ON A GALLERY

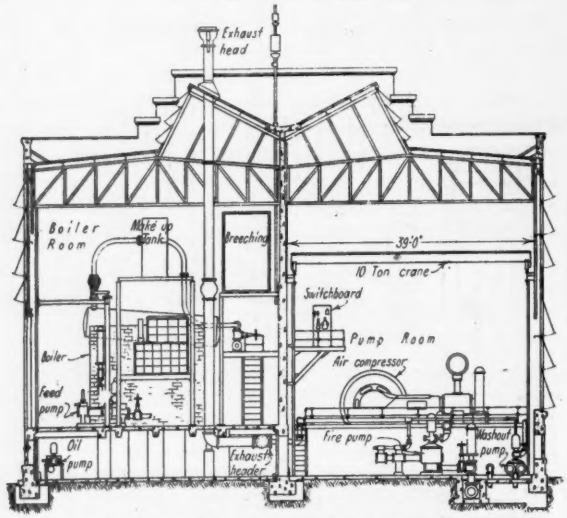


FIG. 6. SYNCHRONOUS MOTORS DRIVE THE TWO LARGE COMPRESSORS AT SAN BERNARDINO

one of the few anthracite mines west of the Pennsylvania district. Coal is dumped from hopper bottom cars into the receiving bins and elevated by a Link-Belt bucket conveyor to a flight conveyor for distribution of the coal to bunkers over the stokers. Ash is handled from the boiler ash pits by push cars to a Robertson & Shaefer skip hoist which discharges into the railroad cars.

Water is pumped from wells by two motor-driven centrifugal pumps and, after passing through the surface condensers, flows into a concrete reservoir. As the water has a constant temperature of about 65 deg., it is a good circulating water but the demand for shop use is not equal to that required for condensing all steam from the generating units during the non-heating season. Nevertheless a fair vacuum is obtained and it is doubtful if a cooling tower would be economical financially.

Water is pumped from the reservoir by a pumping engine with a capacity of 2,500,000 gal. per day while a triple expansion pump of 1,500,000 gal. per day salvaged from the old plant acts as a reserve unit. Both pumps exhaust into surface condensers placed in their suction lines. The power plant also furnishes high pressure superheated steam to two lines each 1000 ft. long reaching to the passenger station and Alvarado Hotel for heating, cooking and laundry use.

For boiler use the water is treated with lime and soda ash in one of the railway company's standard treating plants, while water used for drinking purposes is filtered and passed through a Clow ultra violet ray sterilizer and after being cooled by means of a one ton ammonia ice machine in the power house is circulated through the shops to drinking fountains.

In order to obtain the best results from this plant and to keep it operated at good efficiencies it is liberally

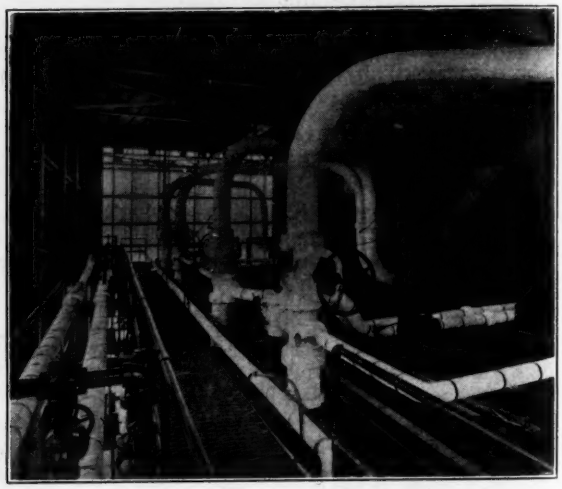


FIG. 7. ARRANGEMENT OF VALVES AND PIPING FOR THE CONVENIENCE OF THE OPERATORS WAS GIVEN MUCH ATTENTION

supplied with power plant recording instruments, including steam flow meters, draft gages and CO_2 recorders. The steam consumption of the generating units is checked by recording steam flow meters and watt-hour meters while the pumps and compressors are checked by meters installed both on the steam lines and on the air and water discharge lines.

San Bernardino Power Plant

At San Bernardino the power plant supplies a shop larger than that at Albuquerque but electric current is purchased from the Southern California Edison Co. at 11,000 v., 50 cycle, 3 phase and is stepped down in a substation on the shop grounds to 2200 v. for distribution. To supply the direct current, two General Elec-

tric 500-kw. motor generator sets have been installed. No exhaust steam is used for heating shop buildings, the necessary heating of offices and passenger station being supplied from high pressure lines.

Four 300-hp. Murray boilers removed from Albuquerque are set 4 ft. higher than they were. Fuel oil is used and at the present time it is fired by the Merit system. Preparations are being made, however, to burn natural gas and then fuel oil will be used only in case of interruption to the gas supply. While it is likely oil or gas will be used as fuel for some time yet, the boilers are so set and foundations so arranged that coal fired stokers and ash handling equipment can be installed. The boilers are connected to a breeching, exhausting into a concrete chimney 189 ft. high and 10 ft. in diameter at the top.

Steam is generated at 150 lb. pressure and supplied to the roundhouse, shops, one steam driven air compressor of 2000 cu. ft. per min. capacity and to the pump room. Boilers are fed by duplicate lines from

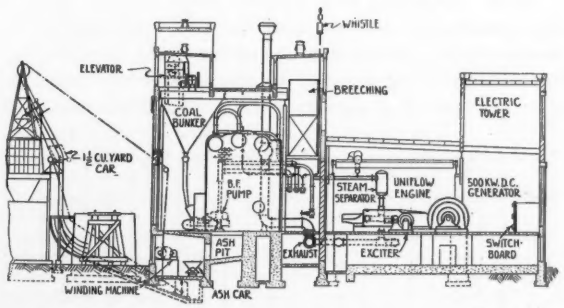


FIG. 8. AT ALBUQUERQUE, ASH IS HANDLED BY A SKIP HOIST

two 14 by 8 by 12-in. Gardner center packed pumps. Feed water is heated in an open Cochrane heater, equipped with a V-notch meter and Copes feed water regulators are used with each boiler.

Motor Driven Compressor Used for Normal Operation

In addition to the steam driven compressor, there are two motor-driven Worthington air compressors of 3500 cu. ft. capacity each driven by 800-hp. General Electric synchronous motors. Normally the motor-driven compressors are operated and steam driven compressor used as a standby unit in case of interruption to the power circuits.

Water supply is purchased from the city of San Bernardino and supplied at 60 lb. pressure to shop mains. As additional fire protection this pressure can be boosted to 130 lb. by a DeLaval steam driven centrifugal pump having a capacity of 2500 gal. per min.

As in the case of the Albuquerque plant, the San Bernardino plant is supplied with indicating and recording instruments in the boiler room and engine room, so that the maximum efficiency can be obtained. Both plants were designed by B. P. Phelps, engineer shop extensions, under the supervision of John Purcell, assistant to vice-president, while the building was carried out under the supervision of the engineering department of the railroad.

Use of Lignite as Fuel

LIGNITE can be satisfactorily burned as domestic and boiler fuel when suitable stoves and grates are provided. This fact means that its use is restricted primarily by the advantage of other fuels in price, convenience, storage, bulk, and rate of combustion, states the Bureau of Mines, Department of Commerce. In the regions adjacent to lignite-producing mines storage is not important; relative price of available fuels is the determining factor. In such regions lignite is naturally the principal fuel used.

Considerable thought has been given to the use of lignite as boiler fuel. From the progress already made, evidently lignite will always be a competitor of other fuels for boilers in the lignite regions. The use of special grates, step grates, chain grates, and underfeed stokers has made possible a fairly high thermal efficiency in the use of this fuel; this possibility added to the fact of an oversupply, usually of the fine sizes—slack lignite—which sell at a very low price, makes lignite attractive as boiler fuel.

Because lignite contains a relatively high percentage of water, approximately 33 per cent, it does not follow that a low thermal efficiency will result from its combustion under a boiler. The actual loss due to the total heat carried away by the water passing out at the usual stack temperature is only 6 to 6.5 per cent of the total heating value of the lignite. Proper combustion facilities only are needed to obtain high thermal efficiency from lignite.

Bureau of Mines Bulletins 21, 40, 89 and 135 and Technical Papers 137, 205, 217 and 279 give complete details. Under test conditions a thermal efficiency of 80 per cent can be obtained by the combustion of lignite boiler fuels. The boiler capacity with this fuel will be less than with high-grade fuels unless large grates and furnaces are provided to accommodate the larger amounts of fuel and ash to be handled. With forced draft giving higher rates of combustion, and approved combustion conditions, the maximum capacity (boiler horsepower developed) is rarely over 140 to 160 per cent of the rated capacity unless a larger grate area is provided than that for bituminous coal. With large grates and furnaces and forced draft, 275 per cent of boiler rating has been attained. It is entirely possible to attain high boiler capacities with lignite with suitable design of grates and furnace, but this cannot be done with the usual proportions that have been determined with high-grade coal.

The Department of Commerce announces that, according to data collected at the biennial census of manufacturers taken in 1926, the establishments engaged primarily in the manufacture of pumps and pumping equipment reported in 1925 a total output valued at $120,148,157, an increase of 29.3 per cent as compared with $92,930,056 for 1923, the last preceding census year.

During the same period the number of establishments increased 10.5 per cent; the average number of wage earners increased 23.2 per cent; the average wage earnings increased 26.4 per cent; the average cost of materials, including fuel, electric power and mill supplies, increased 46 per cent; the value added by manufacture, 19.4 per cent; and the horsepower, 47.5 per cent.

Operating Costs of the Pasadena Power System

Complete Data on Capital Investment, Operating Costs, Revenue and Return of a Municipal System Serving a Population of 50,000. By Claude C. Brown

PASADENA, CALIFORNIA, with a population of some 50,000 people, is served with electric lighting and power by means of its municipally owned and operated electric generating and distributing system.

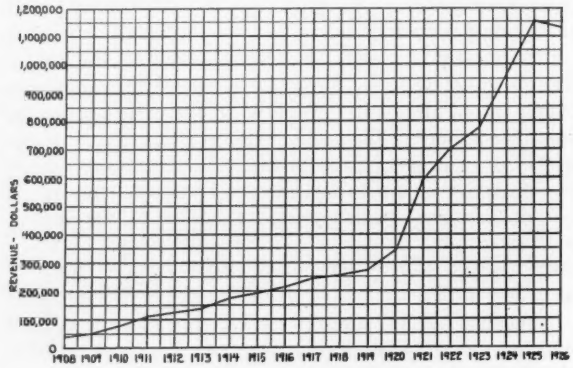


FIG. 1. REVENUE FROM COMMERCIAL LIGHT AND POWER, 1908-1926

This service is utilized for domestic, commercial, industrial and street lighting, electric refrigeration, cooking, heating, and for all classes of power purposes. Pasadena is not an industrial center, but a high class residential city with a limited number of industries numbering probably 200.

Power Plant

The electric generating station contains a total of 5828 rated boiler horsepower in B. and W., Stirling and

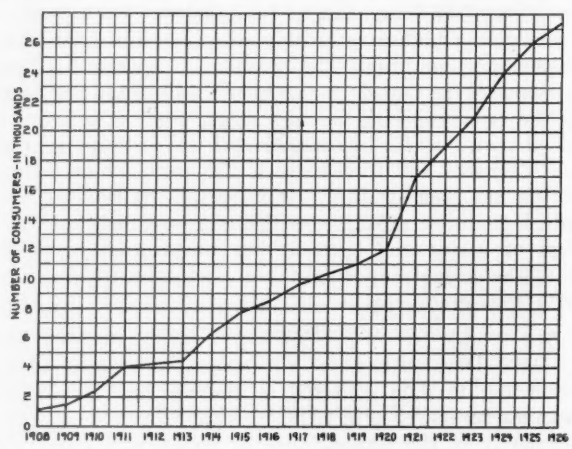


FIG. 2. NUMBER OF CONSUMERS, 1908-1926

Connelly boilers. These boilers are equipped so that they can either be fired with fuel oil or with natural gas. The present price of fuel oil of 18,000 B.t.u. per lb. heat content is $1.00 per bbl., whereas the price of natural gas having a heat content of 1150 B.t.u. per cu. ft. is 16 cents per thousand cu. ft.

The electric generating equipment of the plant consists of—

1900 hp. in cross-compound condensing engines
18,100 hp. in Parsons steam turbines

These units are good for about 22,000 hp. The installation of an additional 15,000-kw. turbine is contemplated during the first part of 1927.

During certain portions of the year, generally during the summer months when the supply of natural gas is abundant, it has been found to be economical to operate the generating plant. At other times when the hydro-electric utilities have surplus hydro power, it has been found to be more economical to purchase this surplus power.

The distribution plant of this system consists of overhead and underground circuits supplying a total of 1503 line transformers having a total capacity of 22,692 kv-a. connected to a total of 27,439 meters.

This, therefore, is a typical small system and for this reason it is believed that the following figures outlining capital investment, operating costs, revenue, and return will be of interest to many who are connected with systems of a similar nature. In presenting data

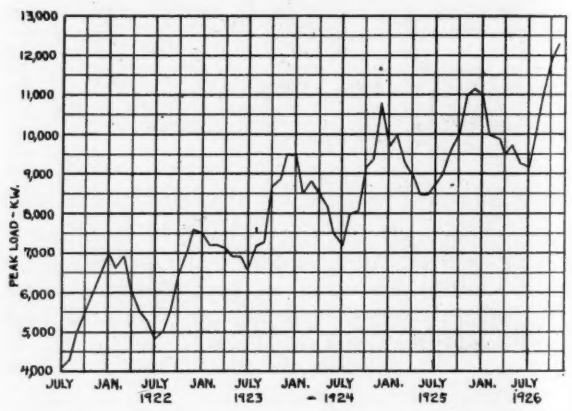


FIG. 3. MONTHLY PEAK LOADS

of this kind the arrangement must, of necessity, be somewhat haphazard, and in the following, no particular reason can be given for the order in which the data are presented.

Kw-hr. Output for Year Ending June 30, 1926

Street Lighting—	kw-hr.
Clusters and alleys	946,673
Series Mazdas	1,035,480
Total	1,982,153
Commercial System—	
Commercial lighting	7,139,433
Residence lighting	9,144,516
Commercial power	13,947,232
Residence power	965,195
Total	31,196,376

Total power sold	33,178,529
Power used on system	45,570
Transformer losses	1,505,615
Shunt loss meters	468,459
Transmission losses	4,417,675
Total	6,391,749
Power purchased	18,743,038
Power generated	20,872,810
Total	39,615,848
Load factor system	40.74%
Maximum demand	11,100 kw.

Return for Year Ending June 30, 1926

Investment—	
Real estate and buildings	$ 265,220.60
Station equipment—boilers, generators, etc.	800,399.66
Overhead lines—substations, services, etc.	634,514.06
Underground lines—conduits, cables, etc.	141,671.80
Transformers and devices	124,472.57
Meters	199,968.84
Municipal street lighting equipment	98,676.99
General equipment	47,474.70
Telephone lines	7,834.24
Total investment	$2,320,233.46
Revenue (Operating)—	
Municipal street lighting	$ 76,195.52
Commercial light and power	1,056,564.43
Total revenue	$1,132,759.95

Operating Expense

Production Expense—	
Operation superintendence	$ 4,305.62
Steam production labor	9,970.58
Station labor	11,830.72
Miscellaneous labor	2,781.67
Fuel	102,242.65
Water	3,897.30
Supplies	3,753.15
Maintenance of structures	3,955.14
Maintenance boiler plant equipment	5,114.86
Maintenance steam power plant	3,974.85
Maintenance miscellaneous power plant	1,195.86
Purchased power	102,611.56
Total production expense	$ 255,633.96
Distribution Expense—	
Distribution superintendence	$ 7,614.92
Distribution substation labor	319.38
Distribution substation supplies and equip.	333.58
Distribution maps and records	371.40
Labor and expense undergrnd. dist. system	723.32
Labor and expense overhead system	2,376.12
Removing and setting transformer	4,234.42
Charging service	6,898.36
Removing and setting meters	1,756.96
Meter department salaries and expenses	10,961.09
Miscellaneous distribution expense	11,060.16
Maintenance distribution structures	188.69
Maintenance dist. substation equipment	2,818.02
Maintenance dist. poles, towers, fixtures	29,217.28
Maintenance dist. overhead conductors	22,689.73
Maintenance dist. underground conduit	1,784.96
Maintenance dist. underground conductors	2,568.25
Maintenance line transformers	4,346.46
Maintenance services	11,067.09
Maintenance consumers meters	1,682.01
Distribution rents	1,177.02
Commercial lamps	4,164.02
Municipal street lamps—operation	940.99
Maintenance street lighting equipment	24,366.95
Total distribution expense	$ 153,661.18
Commercial Expense—	
Commercial labor	$ 21,218.44
Commercial supplies and expense	7,241.97
Meter reading	10,487.46
Collecting	8,800.86
Commercial rents	2,880.00
Advertising	2,829.82
Total commercial expense	$ 53,458.55
General Expense—	
Salary and expense general offices	$ 5,990.32
Salary and expense general office employes	20,754.44
General office rents	1,572.80
General office supplies and expenses	3,647.40
Miscellaneous office expense	404.50
Law expense	2,280.60
Insurance	83.16
Injuries and damages	3,632.45
Relief and welfare work	1,676.75
Miscellaneous general expense	390.61
Maintenance general office structures	2,347.29
Maintenance commercial system	687.69
Maintenance miscl. structures and equip.	4,851.20
Joint operating expense	4,999.98
Accounts collectible	1,738.61
Total general expense	$ 55,057.80
Grand total—operating expense	$ 517,811.49

Operation Summary

Capital investment		$2,320,233.46
Estimated rate base		2,500,000.00
Operating revenue	$1,132,759.95	
Interest revenue	13,868.13	
Miscellaneous	17,593.16	
Total revenue		$1,164,221.24
Operating expense	$ 517,811.49	
Depreciation	158,963.67	
Bond interest expense	49,435.41	
Total expense		$ 726,210.67
Net revenue		438,010.67
Per cent return		17.5%
If this system had to pay taxes their amount would be		$ 132,208.05
Which would reduce the net revenue to		305,802.62
With a per cent return of		12.2%

Unit Costs

The unit costs of this system for the year ending June 30, 1926, were as follows:

	Generated and Purchased	Sold
Production	$0.00645	$0.00771
Distribution	0.00388	0.00463
General	0.00274	0.00327

Depreciation	0.00264	0.00315
Interest	0.00401	0.00479
Total	$0.01972	$0.02355

Capitalization per dollar of gross revenue....$ 2.12
Income per capita..... 14.55
Cost of street lighting per capita..... 0.952
Average rate per kw-hr. received for street lighting 0.03844
Average rate per kw-hr. received for residence lighting 0.046
Uncollectible bills were 1% of gross receipts.
Kw-hr. per capita per year.....415.
Investment per thousand kw.-hr. sold.....$ 6.99

DEPRECIATION

Account	Life Years	Rate %	Value June 30, 1926	Depreciation
Steam power plant land	..	..	$ 64,688.47	.....
Steam power plant structures	20	5	141,706.87	$ 34,201.89
Boiler plant equipment	25	4	442,101.40	130,518.60
Steam power plant equipment	25	4	689,215.72	201,931.04
Miscellaneous power plant equipment	25	4	1,644.49	112.31
Distribution land	..	..	32,429.30	.....
Distribution structures	20	5	23,111.89	4,086.49
Distribution substation equipment	20	5	199,314.84	52,844.85
Distribution poles tower fixtures:				
Distribution: (a) Poles	16-10	6.4-10	97,925.74	65,660.93
Distribution: (b) Hardware and all fixtures	20	5	101,141.34	26,841.59
Distribution overhead conductors:				
Distribution: (a) Wire	50	2	344,176.29	95,862.44
(b) Insulators, switches, etc.	20	5	23,225.31	8,334.71
Underground conduits	25	4	33,620.34	2,523.46
Underground cables	33⅓	3	123,506.14	12,931.22
Line transformers	25-20	4-5	201,879.66	77,407.09
Services	20	5	218,371.40	100,753.55
Consumers meters	20	5	305,745.40	105,776.56
Miscel. dist. capital	25	4	738.57	41.77
Street lighting equipment:				
(a) Poles	16-10	6.4-10	93,771.80	66,445.05
(b) Incandescent fixtures	20	5	26,699.59	13,605.57
(c) Miscel. hardware, wire cables, etc.	50-20	2-5	124,272.25	66,055.62
General office equipment	10	10	16,030.96	10,083.23
Other general lands	..	..	16,532.02	.....
Other general structures	20	5	33,874.78	8,814.35
General shop equipment	10	10	22,562.03	10,934.31
Stores department equipment	10	10	3,461.72	1,323.51
Transportation department equipment	5	20	62,991.74	35,380.91
Communication system equipment	10	5	8,392.98	558.74
Miscellaneous general equipment	10	10	2,178.74	2,028.53
Total			$3,455,291.78	1,135,058.32

RATES

STREET LIGHTING

80 c. p. Mazdas	$12.00 per year
100 c. p. Mazdas	15.00 per year
400 c. p. Mazdas	45.00 per year
600 c. p. Mazdas	50.40 per year
Cluster posts	0.0325 per kw-hr.
Average rate received per year	0.03844 per kw-hr.

ELECTRIC LIGHTING

		Per kw-hr.
First	100 kw-hr. per meter per month	$0.05
Next	400 kw-hr. per meter per month	0.045
Next	500 kw-hr. per meter per month	0.04
Next	1000 kw-hr. per meter per month	0.035
All over	2000 kw-hr. per meter per month	0.03

Minimum charge 50c per meter of 3 kw. capacity or less and 75c for each additional kw. of meter capacity required.

POWER, HEATING, ETC.

		Per kw-hr.
First	150 kw-hr. or less per month	$0.04
Next	150 kw-hr. or less per month	0.035
Next	200 kw-hr. or less per month	0.03
Next	500 kw-hr. or less per month	0.027
Next	500 kw-hr. or less per month	0.026
Next	500 kw-hr. or less per month	0.025
Next	1000 kw-hr. or less per month	0.022
All over	3000 kw-hr. consumed per month	0.015

(Direct current 20 per cent higher.)

Minimum charge 55c per month per hp. of installed capacity, not less than $1.50 per month for 3-phase 2 hp. and $1.00 for single phase 2 hp. or less.

OPERATION REPORT

YEAR ENDING JUNE 30, 1926

Revenue	$1,132,759.95
Expenditures	517,811.49
Balance for bonds, interest, depreciation and profit	$ 614,948.46
Bond interest, 1902 to 1924 issues	140,110.41
Balance applicable to interest reserve, depreciation and construction	$ 474,838.05
Kw-hr. output purchased and generated	39,615,848 kw-hr.
Production cost power purchased and generated	$0.00645
Production cost power sold	0.00771
Distribution cost power sold	0.00463
Commercial cost power sold	0.00161
General cost power sold	0.00166
Total cost power sold, exclusive of interest and depreciation	0.01561

Some Hydraulic Methods of Ash Disposal

VARIOUS TYPES OF OPEN AND ENCLOSED SLUICES, USING EITHER CONTINUOUS FLOW OR INTERMITTENT HIGH-VELOCITY JET, FIND APPLICATION IN SEVERAL MODERN PLANTS

DURING the past few years there has been a notable increase in the number of power plants using the water sluice for removal of ash discharged from ash hoppers under the furnaces. Plants of all types and sizes have employed this method, using, in some cases, sluiceways designed by themselves and in other cases manufactured sluices. It is not the intention of this article to enter upon a discussion of the advantages and disadvantages of the ash sluice as compared with other forms of ash disposal equipment. It is rather the intention to describe briefly some of the ash sluicing systems that have already been installed. Although most of the plants mentioned here are central stations, the fundamental principles brought out are applicable to any type of plant.

Various sluicing arrangements and methods have been used, typical examples of which are given below.

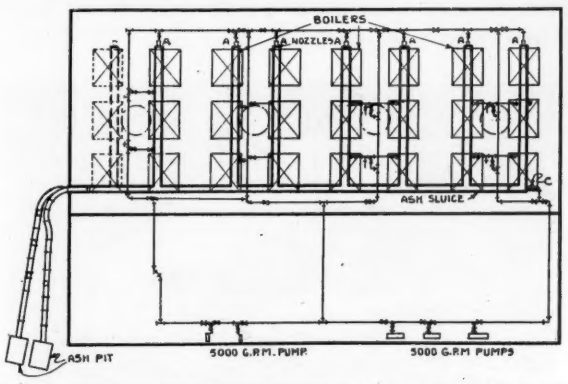


FIG. 1. OPEN FLUMES WITH NOZZLES AT A AND C ARE USED AT HELL GATE

These include both pitched and horizontal sluices, of either open flume or enclosed type, using both the continuous water flow system and the intermittent high-velocity jet. In some cases ash is dropped through gates in the bottom of the hopper directly into the sluice; in other cases, in a type of sluice that will be described, ash is dropped onto feed plates whence it is fed gradually to the sluice. Precautions are usually taken to prevent the dropping of large clinkers directly into water in the sluices. This is partly because of the possibility of clogging (the feed plate and high velocity jet method is designed to prevent this) and partly because of the danger of creating gas in the boiler room basement. Precautions are also taken to prevent dry ash from falling through the air from the furnace bottom, as this creates almost unendurable dust and gas. In many cases, soot and fly ash blown from surfaces of economizers, air heaters, flues and the like, are conducted through pipes down to the main ash sluice.

After the ash has been sluiced out of the boiler house, it may be discharged to a pit from which it can be removed by a crane, it may be discharged or pumped to a tank where the water can drain out, or it may be pumped or allowed to flow directly to a place on the plant property where it can be used for filling. For pumping a mixture of ash and water, dredge pumps or other special manganese steel pumps are ordinarily used. An interesting account of how ash is pumped 2100 ft. at the Rockford Electric Co. was given in the October 1, 1926 issue of Power Plant Engineering.

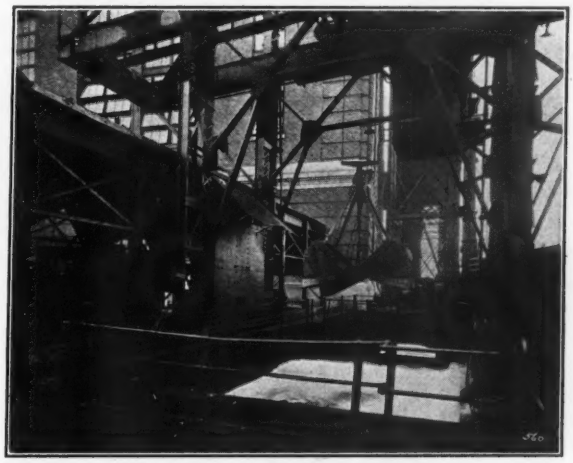


FIG. 2. AT HELL GATE, ASH IS REMOVED FROM SUMP BY GRAB BUCKET

One of the most interesting sluicing systems is the one installed at the Hell Gate plant of the United Electric Power Co., designed by Thos. E. Murray, Inc. The general layout is shown in Fig. 1, serving 24 boilers fired by underfeed stokers with clinker grinders. This is a system of open flumes within the boiler room continuing through a closed pipe to the ash settling tank. Tributary flumes are carried along below each line of boilers and empty into a main cross-flume which runs along the boiler room wall near the turbine room. This main flume then turns and becomes a full pipe or enclosed conduit leading to a pit near the river side, into which it discharges. Ash is recovered from this pit, as shown in Fig. 2, by a grab bucket operated by a locomotive crane running on a track laid on the pier. The bucket delivers the ash to hoppers, from which trucks can be loaded without delay, removing the ash for filling and building purposes. The bucket can also deliver to barges on the opposite side, if this is desirable.

Flumes within the boiler room are of concrete with a bottom lining. Those under the boilers are supported on structural steel frame work suspended from the firing floor, while the main cross-flume is carried on steel trestling. Ash as it leaves the clinker grinders drops directly into the water and is carried away. Access doors lined with common brick are provided so that any obstruction can be handled easily.

Water is supplied by a nozzle A at the head of each tributary flume and in the original design there was an undercurrent nozzle at the beginning of each succeeding ashpit. The use of the latter has been abandoned, since it has been found that the velocity due to the gradient

of the flume is enough to carry the ash. The slope of the flumes is ¼ in. to the foot. At the head of the main conduit is a booster nozzle C.

Water for the various nozzles is taken from the circulating discharge tunnel and is supplied under pressure by 12-in. centrifugal pumps. These pumps are single-stage double suction volute pumps and supply 5000 g.p.m. against a head of 75 ft., operating at 81.5 per cent efficiency. The motors are rated at 150 hp. but the pumps require only 125 hp. under regular operating conditions.

The main pipe line which supplies the water nozzle has a bore of 16 in. and is arranged as a ring, as shown.

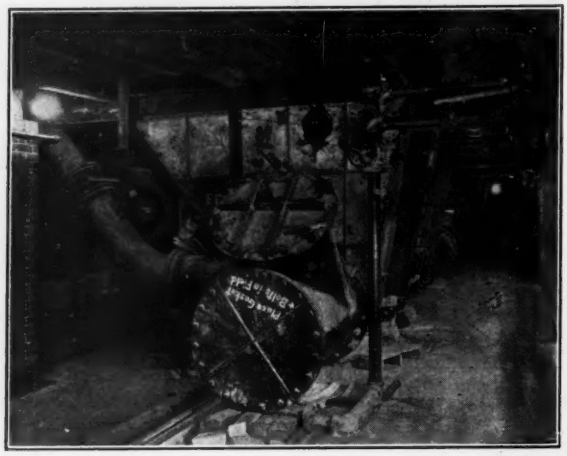


FIG. 3. ASH SLUICE AT TWIN CITIES PLANT OF FORD MOTOR CO.

The valves controlling the supply of water to the individual nozzles are located in the basement convenient to the flumes, so that adjustment of the flow of water along the flumes can be made easily and quickly.

It will be noticed that these ashpits are not sealed but, with the amount of ash lying on the clinker grinders in usual operation, any serious excess air is not to be expected with the forced draft stokers used.

In the settling basin into which the ash discharges, a submerged barrier is arranged around the outside in such manner that the discharged water velocity is reduced so that very little material will be carried away by this discharged water. The submerged barrier also very effectively prevents the floating material from being carried over. Under normal conditions three pumps are usually operated and deliver approximately 15,000 gal. per min.; about 150 t. of ash are handled per day, which gives a ratio of approximately 540 lb. of water per pound of ash on the average. This ratio is somewhat higher than is actually required but it has been found more economical to operate some of the pumps continuously rather than employ the necessary labor for starting and stopping the pumps as the occasion permitted. It is also thought that a somewhat larger quantity of water lessens wear on the flumes and connecting piping. As the principal item of expense in the operation of this system is for maintenance of the liners in the flumes and connecting piping, the larger quantity of water might justify the additional expense for power if it reduced this item to any appreciable extent. The open flumes and tributary flumes are now lined with various linings to determine the most satisfactory material for this service. Chilled iron, white iron and manganese steel liners are being used but none of these materials has been in service for a sufficient length of time to balance the cost against the endurance. This system of disposing of the ash is considered successful and economical by the company.

In the 1923 extension which Dwight P. Robinson & Co. made to the Colfax Station of the Duquesne Light Co. was included an ash sluicing system for the boiler plant. This equipment was designed to serve eight 2768-hp. pulverized fuel fired boilers, five of which are now in operation.

These boilers are set four in a row facing a central aisle. The receiving pit for the sluicing system is located in the basement in the center of the boiler run. Two metal-lined sluiceways are run in the basement floor under each boiler. The maximum length of sluice from the far boiler to the receiving pit is 75 ft. and sluicing nozzles are placed at intervals of 25 ft. These nozzles are supplied with water by a 1500-g.p.m. centrifugal pump operating at 142-ft. head; 90 hp. is required to drive the pump.

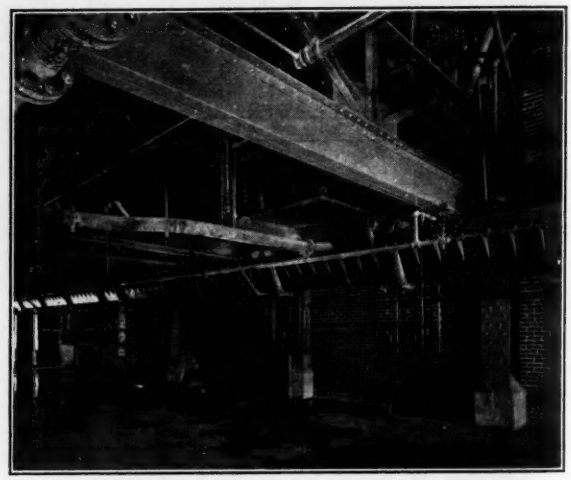


FIG. 4. ASH SLUICE AT HUNLOCK CREEK STATION

Total ash dumped into the sluice pit from the five boilers now operating is from 17 to 18 t. a day. The boiler ashpits are dumped into the sluiceways once every 8-hr. shift. A total of 6 hr. per day covers the time required for this operation. The services of two men and the operation of the sluice pump at full load are required during this period. Ash is removed from the central pit and dumped into trucks or cars once every 48 hr. This requires the service of one man and a traveling bucket hoist for a period of 2½ hr.

Sluiceways used in the ash sluicing system at the Trenton Channel plant of The Detroit Edison Co. consist of cast iron parabolic-shaped sluices 16 in. deep and 20 in. wide at the top, built of 8-ft. sections bolted together at the ends by means of flanges. The flanges serve as feet for supporting the sluiceway. To prevent wear of the casing, renewable white iron liners are installed along the wearing surface of the sluiceway. The slope of the sluiceways is approximately 2 per cent.

Present installation consists of three sluiceways each serving three boilers. Approximately 65,000 lb. of ash are disposed of in 24 hr. but it is only necessary to operate the sluiceways one hour out of every eight to take care of this amount of ash. During the remainder of the time, the ash is allowed to accumulate in the hopper under each boiler and the ash sluices are not operated. The possibility of doing away with ash gates and sealing the hopper with water in the sluice was considered. It was found that in a pulverized coal installation, such as is used at Trenton Channel, with only a tube screen between the ashpit and furnace, there would be a radiation of heat to the ashpit and if the ashpit were sealed with water there would be considerable heat loss due to vaporizing the water in the ashpit. For this reason it was decided to use sliding gates at the bottom of the ash hoppers. There are four of these sliding gates in the bottom of each ash hopper which are opened one at a time when the ash is dumped. In this way only a small amount of the ash is dumped into the sluiceway at one time so that the ash does not plug the sluice.

Some recent tests have shown that with the depth of water in the sluice at about 6 in. and with the pumps

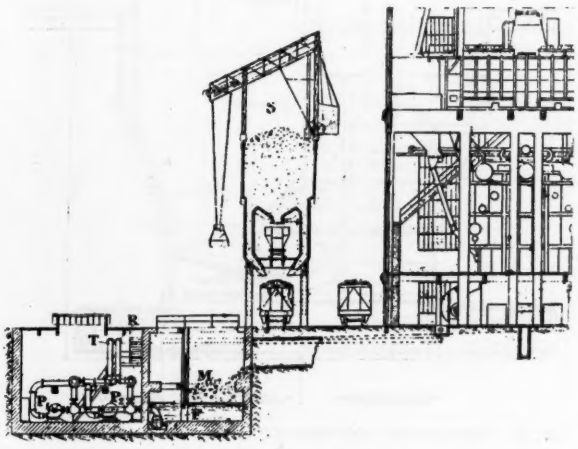


FIG. 5. AT THE NORD ELECTRIC STATION IN PARIS OPEN PITCHED FLUMES ARE USED

delivering 3000 gal. of water a min., a maximum velocity is obtained in the sluice. The sluiceway will handle any ash or clinkers that are formed in the boilers and will also take care of any bricks that may become loose from the lining and fall into the ashpits. During the tests it was found that the water would wash a lump of coal about a foot square down the sluiceway at 175 ft. a minute.

The Twin Cities steam power plant of the Ford Motor Co. at St. Paul uses the ash sluice, Fig. 3. This station has two 1371-hp. boilers fired by pulverized fuel. These boilers are equipped with water screens.

Ash is dumped from the ash hoppers into large cast-iron clinker chambers provided with water quenching nozzles and water feed nozzles. The quenching nozzles, located near the top of the clinker chambers, spray water to cool the falling ash. The lower part of the clinker chambers are divided by cast iron partitions into sections.

Between the clinker chamber and the sluice a grizzly made of heavy cast iron with approximately 10½-in. square openings is installed, so that large clinkers must be broken up before being dropped into the ash sluicing trench. The clinker chambers are also arranged with poke holes and access doors.

In this station a 24-in. extra heavy cast iron pipe serves as an ash trench and carries the ash to a concrete pit, 26 ft. by 18 ft. wide by 6 ft. 4 in. deep. Water at 100 lb. per sq. in. gage pressure is supplied to the ash sluicing system by a 500-g.p.m., 3-stage centrifugal pump direct connected to a 50-hp. motor. From the concrete pit, two 800-g.p.m. manganese steel lined ash

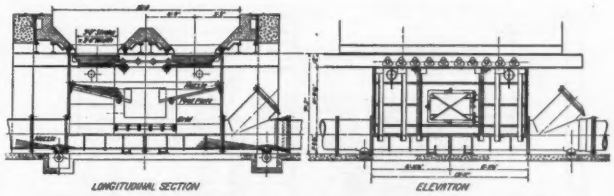


FIG. 6. CAHOKIA REMOVES ASH FROM 16 BOILERS WITH THIS TYPE OF SLUICE

disposal pumps located on the basement floor level, with their suctions down in the sump, discharge the ash through an 8-in. extra heavy, cast iron bell and spigot pipe line out to the center of the lot near the river where the ash is to be used as fill. This 8-in. pipe line has an upward slope of 6 in. per hundred feet so that when the pumps stop running the pipe line will empty itself back into the concrete sump. The 8-in. line discharges into a wooden trough that may be moved about so as to fill in whatever portion of the lot is desired.

An ash sluicing system was installed in the Hunlock Creek Station of the Luzerne County Gas & Electric Corp. by Stone & Webster, Inc., as previously mentioned in these columns. At present three 1300-hp. cross-drum boilers have been installed, provided with chain grate stokers, ash hoppers and ash gates. The ash hoppers are provided with water quenching nozzles to cool the ash.

The ash is dumped directly from the ash hoppers into the ash sluicing trench, Fig. 4. Sluicing nozzles are located on the upstream side of each boiler along the trench. Water for sluicing is supplied through a 6-in. pipe line at 75 lb. per sq. in. gage pressure by the station service pumps.

The bottom of the ash hoppers is high enough above the ground outside so that the cast iron ash trench carries ash overhead, through the basement of the boiler house, to the outside of the building where it connects with a wooden trench that carries the ash out to a nearby vacant lot. The trench in the basement has a 1.25 per cent slope so that gravity helps to carry the ash along. At this plant it takes only 5 or 10 min. to empty an ash hopper.

For some years past water has been used for quenching and carrying off the ash first from four and later from 10 boilers at the Nord Electric Power Station in Paris of the Compagnie de Distribution d'Electricite. This installation has given satisfactory results, the company states in the "Genie Civil" and it has been decided to adopt the same system for the extensions comprising six additional boilers now in progress.

Figure 5 is a vertical section of the boiler house. At each end of the coal storage is a pumping station equipped with two centrifugal pumps, having an output of 220,000 gal. per hr. The pumps deliver water into the highest points of the channels which are about 24 in. wide and have a slope of 2.5 per cent and pass under two rows of five ash chutes in the basement of the boiler house.

When the chutes are to be emptied a pump is started up and, the flow of water having been established, the ash doors are opened, the ash dropping into the stream. The water drains off into the sump, leaving the ash to

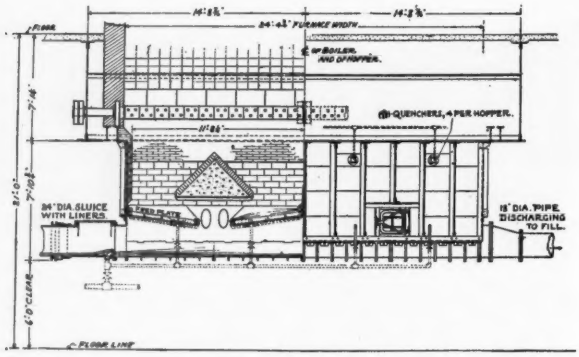


FIG. 7. ASH PASSES THROUGH CLINKER GRINDER TO SLUICE AT HARBOR POINT STATION

be picked up from the ashpit by a grab suspended from a 30-t. crane which travels on the top of a bunker. The crane deposits the ash in the bunker, whence it is discharged either into railroad trucks or into a conveyor which takes it to a brick works on the station site. It is stated that one man can handle the ash from 10 boilers of 22,600 sq. ft. heating surface each.

Figure 6 shows the sluiceway installed at the Cahokia Station of the Union Electric Light & Power Co., designed by McClellan & Junkersfeld, Inc. This sluice is of the horizontal high velocity jet type designed to handle the ash from sixteen 1801-hp. boilers fired with pulverized fuel. The longest run in this sluice is about 280 ft. The main sluice pipe is heavy cast iron 24 in. in diameter. The sluicing nozzles are $\frac{5}{8}$ in. in diameter, spaced equally along the length and directly in back of the connection to each boiler. The pressure on the discharge nozzles runs about 50 to 60 lb. gage and the water used, when sluicing the boiler farthest from the point of discharge of the sluice, is at the rate of about 2000 g.p.m. Boilers are sluiced once every 24 hr. to a central discharge pit where material passing through a 3-in. grid is pumped out and material larger than this is dug out with a grab bucket. About 40 to 50 t. a day of the larger material is removed from the pit.

In this installation, ash drops through the ash gates in the bottom of the hopper onto a feed plate, from which it is washed slowly into the main sluice by the undercutting action of auxiliary nozzles placed as shown. This arrangement, which is a feature of the design advocated by the manufacturer of this sluice, is intended to prevent the dropping of large masses of ash or clinker directly into the water, which might produce gas. It is also designed to provide a constant, even feed while the sluice is in operation. Since the entire sluice is enclosed, the dropping of ash through the air is avoided. In addition, the sluice, as made by this manufacturer, is horizontal, depending on the action of high velocity water jets turned on only when the ash is to be sluiced.

Another sluice of the horizontal, feed-plate, high velocity jet type is shown in Fig. 7. This is installed in the new Harbor Point Station of the Utica Gas & Electric Co., designed by Thomas E. Murray, Inc. It handles the ash from four 1500-hp. boilers fired by underfeed stokers equipped with clinker grinders. The ash hoppers will hold 24 hr. storage of ash, which can be discharged in one hour, allowing 15 min. per boiler. This installation is typical of this manufacturer's sluice as installed with clinker grinders.

For use with chain grate stokers, this type of sluice was also installed at the Tecumseh plant of the Kansas Power & Light Co., described in the Oct. 15, 1926 issue of Power Plant Engineering. As will be seen in Fig. 8, the sluice itself is essentially the same as in the two

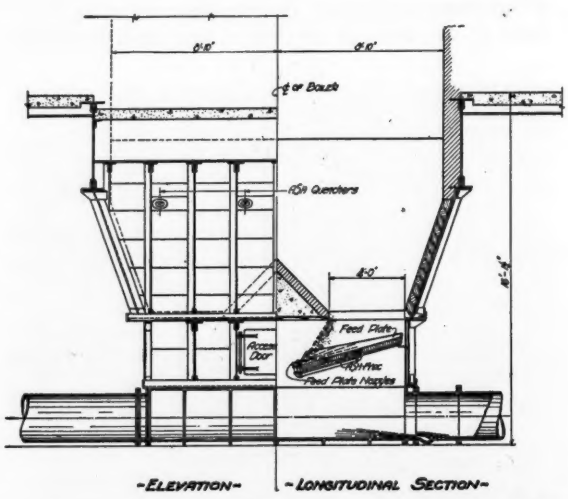


FIG. 8. TECUMSEH DISPOSES OF ASH FROM CHAIN GRATES THROUGH THIS SLUICE

preceding cases. It removes the ash from three 1500-hp. boilers fired by chain grate stokers burning Kansas coal with a high ash content. The 24-hr. accumulation of ash in the hoppers can be discharged to a sump in about 30 min. and the pumping power is given as about 1 kw-hr. per ton of ash.

Using this same type of sluice, in a large steel mill burning coke breeze on chain grate stokers, 15 t. of ash is discharged a day, requiring about 20 min. including starting of the pump and opening and closing of the valves and using about 800 g.p.m. of water at 100 lb. pressure.

Another manufacturer of an enclosed sluice or hydraulic conveyor, as it is called, states that with an 8-in. line in a total conveying distance of 750 ft., elevating 8 ft., 56 t. of ash a day was handled using 250 g.p.m. of water and having a discharge capacity of 12 t. an hour. Another 8-in. line running horizontally for 500 ft. handles 35 t. of ash a day using 225 gal. of water a minute, with a capacity of 15 t. of ash an hour.

Extraction Turbines Improve the Heat Balance

WIDE VARIETY OF DESIGNS MAKES IT POSSIBLE FOR MANUFACTURERS TO MEET ANY CONDITION OF OPERATION DICTATED BY THE HEAT BALANCES OF VARIOUS INDUSTRIES. BY C. A. KELSEY*

SEVERAL YEARS AGO a vigorous campaign was fought to reduce waste in the generation, transmission and application of power in the industrial field and for public use. Public utilities, with the assistance of electrical manufacturing companies, did make considerable progress in that direction and the so-called superpower system, involving the generation of power in larger blocks and the use of a network of transmission lines branching out into the country, was brought into being. While many of the industries have been brought under the scope of the central station, there is a certain class which still continues to generate its own power.

Evidence of the importance of this class, utilizing waste heat in the form of exhaust steam for process work, is seen in the complete redesign of turbines by manufacturers to make the machine better adaptable to the wide range of operating conditions encountered.

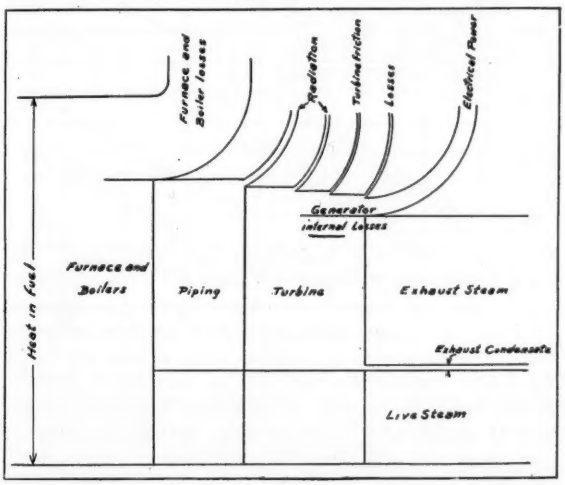


FIG. 1. VARIOUS LOSSES IN THE SYSTEM CAN BE SHOWN GRAPHICALLY ON A HEAT FLOW DIAGRAM

In most cases the decisions as to the equipment to be installed cannot be based on a general rule but require a careful analysis involving the industrial heat balance, which is in reality an economic principle. To be economical the joint production of heat in the form of steam and electric power shall be such that there is no useless excess of one over the other form of energy.

There are certain industries requiring process steam where it is always cheaper to generate their own electric power. On the other hand, it will rarely be found that the utilization of exhaust from a prime mover for building heating alone will pay even though the generation of power by fairly small steam turbines, which are credited with the heat in the exhaust or steam extracted at some intermediate pressure between the throttle and the exhaust, can be done at a higher economy than by the largest and most efficient condensing unit now employed in central stations.

*Ind. Eng. Dept., General Electric Co. Abstract of paper presented before The Western Society of Engineers.

Considering the various furnace, boiler, piping and turbine losses, as in Fig. 1, it is seen that a relatively small amount of heat is actually converted into electric power. Radiation from the turbine itself is small, less than one per cent which may also be taken as approximately the value of the external friction loss of the turbine.

Internal losses of the turbine are indicated by a line set down at some point below. These are friction losses

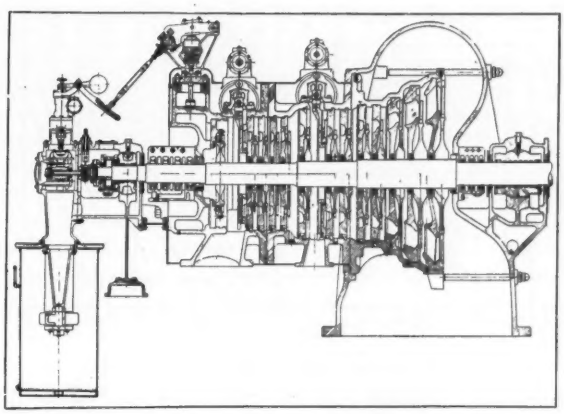


FIG. 2. A CROSS SECTIONAL VIEW OF A DOUBLE AUTOMATIC EXTRACTION CONDENSING TURBINE

representing the bypassing of energy from the steam to the mechanical parts of the turbine. Turbine buckets generate more mechanical power than is delivered to the shaft. The excess power is used up in the friction of the wheel and bucket in the atmosphere of the steam which eventually restores to the steam the heat taken out when it passed through the buckets. This internal loss is akin to engine cylinder condensation where heating up of the main walls at the beginning of the stroke and the passage of the heat from the walls to the cooler exhaust steam at the end of the stroke, tends to re-evaporate some of the moisture in the exhaust steam. Losses in the generator in the average industrial machine may be four or five per cent. The exhaust proper consists of steam and some condensate.

Extraction turbines can be made with a different number of stages for condensing or non-condensing service, and extraction can be arranged at different points. A condensing double extraction unit is shown in cross section in Fig. 2. The inlet is at the left, the steam first going through a double stage wheel into a chamber, then through a grid-iron valve, which can be regulated, through the intermediate stages to a second chamber and grid and finally to the final staging.

Turbines of this type can be regulated in different ways. Automatic control of the load, pressure and quantities of exhaust or extracted steam has been perfected to meet a great number of conditions. The simplest form of automatic control is the maintenance of constant pressure at the extraction opening. This is accomplished by a pressure regulator controlling,

through a piston, the opening of the extraction valve. Temperature can be controlled in a heater by a thermal relay. The exhaust pressure can be regulated by controlling the pressure or the quantity of steam extracted at higher pressures. A combination of two turbines, exhausting at high and low pressures can be used and controlled to maintain a pressure constant in either system by shifting the load from one unit to the other. Different degrees of speed regulation in extraction units can be met by the use of a special form of speed governing mechanism.

Performance of a double extraction noncondensing unit, where steam is extracted from one opening where constant pressure is maintained and from a second opening at which the pressure is not maintained constant, is shown in Fig. 3, for a constant extraction from the non-regulated or reducing valve opening. The pressure at the regulated opening varies with the load and with the quantities of steam extracted from the pressure regulated or automatic extraction opening. There is a curve drawn for 15,000 lb. at 100 lb. gage, 10,000 lb. at 100 lb. gage, and 0 lb. or no extraction from the constant pressure opening. These curves are plotted against the output in kilowatts and the resultant flow to the throttle. In a turbine of this kind steam is extracted from the first opening at constant pressure maintained automatically by an internal valve and from the second at a variable pressure with the flow controlled by an external reducing valve.

When extracting different quantities of steam at the lower extraction opening the pressure in the non-regulating extraction opening will vary. Intersections of the curves show the pressures resulting for specific conditions. It is impossible to show all the variable quantities on one curve, and so for a complete analysis a number of these curves must be drawn.

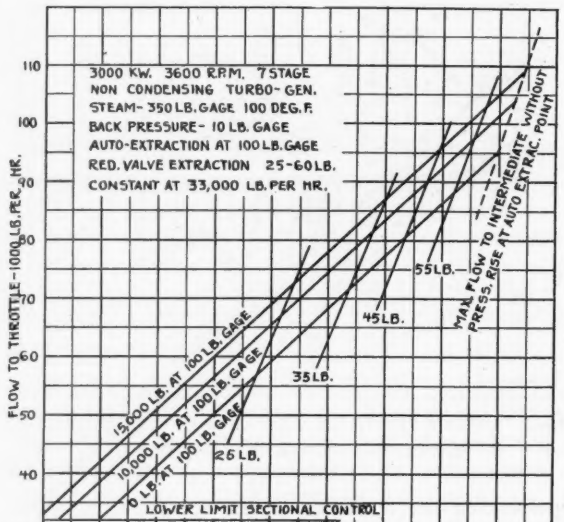

3000 KW. 3600 R.P.M. 7 STAGE
NON CONDENSING TURBO-GEN.
STEAM-350 LB. GAGE 100 DEG. F.
BACK PRESSURE-10 LB. GAGE
AUTO-EXTRACTION AT 100 LB. GAGE
RED. VALVE EXTRACTION 25-60 LB.
CONSTANT AT 33,000 LB. PER HR.
FLOW TO THROTTLE-1000 LB. PER HR.
OUTPUT 100 E.KW.
15,000 LB. AT 100 LB. GAGE
10,000 LB. AT 100 LB. GAGE
0 LB. AT 100 LB. GAGE
55 LB.
45 LB.
35 LB.
25 LB.
MAX. FLOW TO INTERMEDIATE WITHOUT PRESS. RISE AT AUTO EXTRAC. POINT
LOWER LIMIT SECTIONAL CONTROL

FIG. 3. THE PRESSURE AT A NON-REGULATED EXTRACTION POINT OF A TWO POINT EXTRACTION TURBINE VARIES WITH THE AMOUNT OF STEAM BEING EXTRACTED FROM EITHER OR BOTH OPENINGS AND THE ELECTRICAL LOAD

Curves in Fig. 4 show for the same machine the flow to the throttle corresponding to different extractions of steam from the first or automatic regulated opening at 100 lb. page. They also show the flow to the throttle for different amounts of steam extracted from the lower opening, in this case from 50 to 60 lb. maximum. The flow of steam is limited to the maximum flow of the turbine or at part load, to the output of the machine, which happens to be 3000 kw. and to the minimum flow to the intermediate stages without giving an excessive rise in pressure at the first extraction opening. There is, therefore, a curve at the bottom limiting the flow to the throttle for a given load and given conditions of steam extractions at the two pressures.

The sum of the steam extracted at 100 lb. from the first opening and the steam extracted from the second opening at whatever pressure resulting, as shown on the other curve, subtracted from the flow to the throttle, gives the flow to the exhaust. These curves serve to indicate the amount of work necessary on the part of the manufacturer for assisting the industrial plant and determining the type of turbine which can be used to give the proper heat balance.

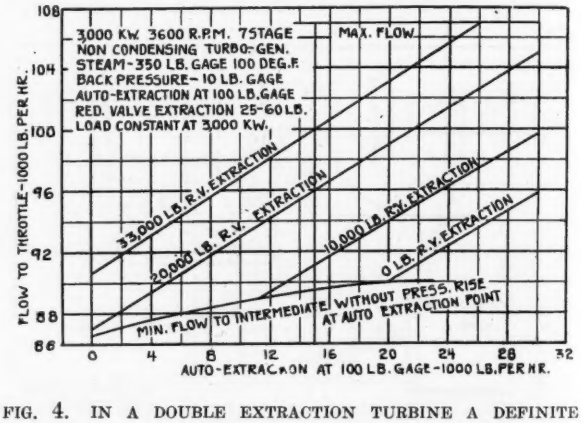

3000 KW. 3600 R.P.M. 7 STAGE
NON CONDENSING TURBO-GEN.
STEAM-350 LB. GAGE 100 DEG. F.
BACK PRESSURE-10 LB. GAGE
AUTO-EXTRACTION AT 100 LB. GAGE
RED. VALVE EXTRACTION 25-60 LB.
LOAD CONSTANT AT 3,000 KW.
MAX. FLOW
33,000 LB. R.V. EXTRACTION
20,000 LB. R.V. EXTRACTION
10,000 LB. R.V. EXTRACTION
0 LB. R.V. EXTRACTION
MIN. FLOW TO INTERMEDIATE WITHOUT PRESS. RISE AT AUTO EXTRACTION POINT
FLOW TO THROTTLE-1000 LB. PER HR.
AUTO-EXTRACTION AT 100 LB. GAGE-1000 LB. PER HR.

FIG. 4. IN A DOUBLE EXTRACTION TURBINE A DEFINITE MINIMUM FLOW TO THE INTERMEDIATE STAGES OF THE TURBINE IS NECESSARY TO PREVENT EXCESSIVE PRESSURE AT THE FIRST OPENING

Turbines can be furnished not only to regulate the quantity of steam extracted and for balancing up the pressure between the two systems, but can also be provided with very sensitive governors. There are governors developed which anticipate the decrease in output of an extraction turbine with a sudden demand for extraction steam. These governors momentarily increase the flow of steam at the throttle to prevent robbing the steam from the final stages of the machine.

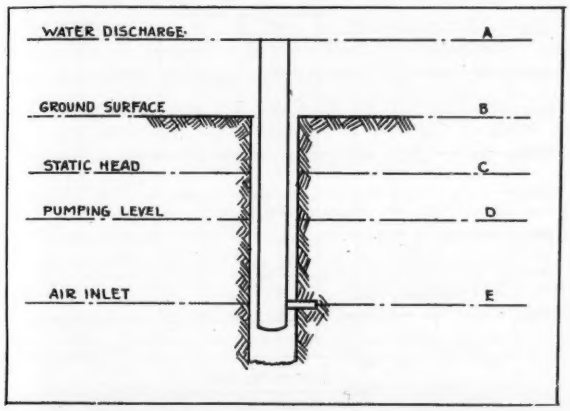
Most manufacturers are prepared to design for almost any manner of operation that may be required by an industrial plant to meet particular conditions. Good judgment must, however, be exercised in the selection of types required. Quite likely the first solution which would give an acceptable heat balance does not give the lowest cost of operation or it may be desirable to make another study with changes in the size or type of the unit so as to provide for expansion with the least expense.

Practical Installation of the Air Lift

By H. T. Abrams*

WIDESPREAD APPLICATION of the air lift for pumping fluids and semi-fluids of all kinds has made this method of pumping of interest to all industries.

In its simplest form, the air lift consists of a pipe for water and a pipe for air, both suspended in the well. These pipes should be submerged to a certain depth, proportionate to the lift when the pump is at work.



A CALIBRATED GAGE ON THE AIR LINE MAY BE USED TO DETERMINE PUMPING HEAD

Water being free to enter the lower end of the water pipe, will rise to the same level inside of the pipe as it stands outside. Air introduced through the base of the water pipe, aerates and reduces the weight of the contents of the rising main, which are subsequently moved upward by the buoyancy of the air bubbles aided by the greater weight of the solid column of water in the well surrounding the eduction pipe and causes a continuous stream to flow upward to the point of discharge. The necessity of the proper ratio of submergence to the lift is one of importance and is the governing factor in the design of such a pump.

In practice the total lift or head enters into all calculations for air lifts. Often the actual pumping level in a well or group of wells is not known; however, it is possible to secure fairly accurate information from the well drillers' tests, or from characteristics of wells in the immediate vicinity. Frequently air is available for testing wells. Where this situation exists, a convenient and accurate method of obtaining the pumping head is by the use of the calibrated gage. A globe valve and gage should be placed on the air pipe near the well. The length of air pipe in the well must be known exactly.

Then the compressor should be started and when the water first emerges from the well the pressure should be read. This is called the starting pressure. Then, after the well is in operation for a time necessary to bring about normal operating conditions, the gage should be read again. This reading gives what is known as the operating or working pressure. Then the valve should be closed and the gage watched closely. The pressure will fall and come to a stop and, at the time when the water ceases to flow from the discharge pipe, the pressure should be read again. This pressure, at the momentary stop is what is known as the shut in pressure, and is the point where the head of water balances the pressure in the air pipe. This reading should be taken several times so a fair average may be obtained.

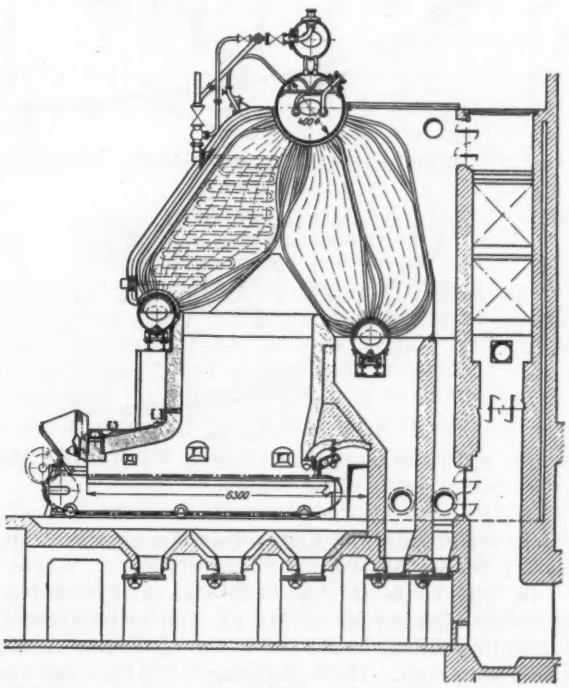
For example, the well in which is installed 150 ft. of air pipe, shows a starting pressure of 60 lb. a working pressure of 50 lb. and a shut in pressure of 48 lb. The starting pressure corresponds to 138 ft., which is the starting submergence. The static head "C" is therefore 150 — 138, or 12 ft., while the working submergence is 48 lb. or 110 ft., giving a pumping head "D" of 150 — 110 or 40 ft.

The lift or head being determined, the proper submergence should be taken so that good efficiency may be obtained, while extreme care should be given to the design of the eduction pipe, as the success of an air lift depends a great deal upon this feature. The eduction pipe should be designed for the quantity of water being pumped, so that the proper velocity may be obtained.

*Ingersoll-Rand Co.

Increasing Heat Transmission with Small Tubes

BASED ON experience with air preheaters and other heat exchangers, it can be assumed that the far-reaching division of the gas stream into the thinnest possible lines by the use of small and closely placed tubes assures favorable conditions for heat transmission. In a test on a small-tubed marine type vertical boiler at the



SCHULZ VERTICAL TUBE BOILER AT THE GERMANIA SHIPBUILDING YARD, KIEL

Germania ship yard, Kiel, 357 deg. C. (675 deg. F.) flue gas temperature was obtained back of the boiler at a CO_2 content of 14 per cent and a heating surface load of 44.25 kg. per sq. meter per hr. (9.06 lb. per sq. ft. per hr.). This boiler has no baffling, the stream of gases being guided only by the closely placed tubes.—Translated from Archiv fuer Waermewirtschaft by John H. D. Blanke.

Some Operating Troubles with Turbo-Generators

VARIOUS operating troubles on 17 different turbines during the last 4 yr. resulted in a thorough investigation to discover and remove the causes. The

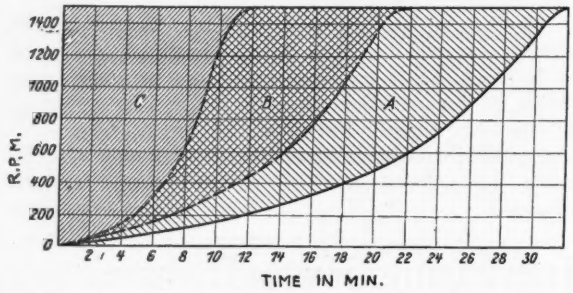


FIG. 1. STARTING CONDITIONS FOR ALL TURBO-GENERATORS: A, NORMAL; B, RAPID; C, FORBIDDEN STARTING PERIOD

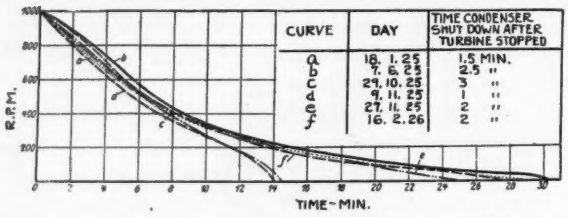

R.P.M.
TIME-MIN.
CURVE | DAY | TIME CONDENSER SHUT DOWN AFTER TURBINE STOPPED
a | 18. 1. 25 | 1.5 MIN.
b | 7. 6. 25 | 2.5 "
c | 29. 10. 25 | 3 "
d | 9. 11. 25 | 1 "
e | 27. 11. 25 | 2 "
f | 16. 2. 26 | 2 "

FIG. 2. SHUTTING DOWN CURVES OF A 6000-KW., 1000-R.P.M. TURBO-GENERATOR

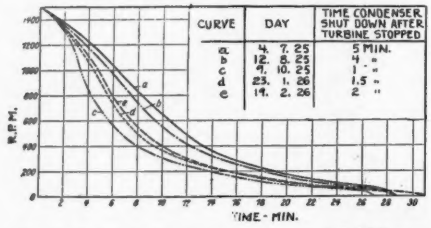


FIG. 3. SHUTTING DOWN CURVES OF A 16,000-KW., 1500-R.P.M. TURBINE

results are given in the Archiv. fuer Waermewirtschaft, Nov., 1926, pp. 305-308.

In one turbine the last blade was worn down considerably after service of 1½ yr. due to poor water-removal conditions in the lower housing and to unsuitable blade metals. The load during 5 to 8 hr. a day was only 10 per cent, which caused considerable wet steam.

In another case the foundation of a 20,000-kw. turbo-generator in the Moabit power plant sank and had to be repaired. Later a short circuit in a transformer station during a 100,000-kw. load caused injury to four wheels of this turbo-generator. The turbine operated two days longer, then operation became more fluctuating and the foundation dropped about 0.08 in. To find the cause of this sinking of the foundation, the turbine was, contrary to starting practice, not warmed up preceding operation. Warming up caused fluctuating operation in the turbine due to the irregular warming of the parts.

To determine during which method of starting the operation would be the smoothest, an extension rod was bolted to the turbine from which a bucket of water was suspended. Oil or water-filled containers were also placed on various parts of the floor. The size and length of the vibrations on the liquid gave a factor for measuring the fluctuating operation of the turbine.

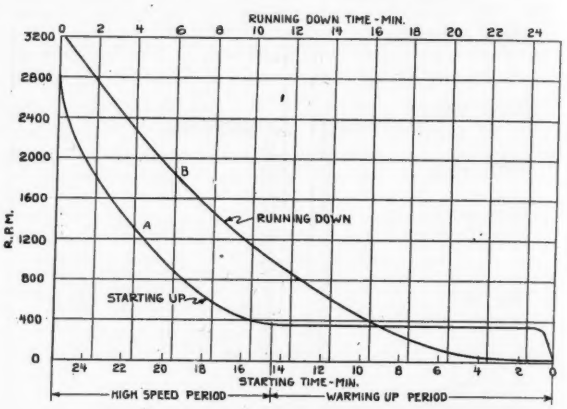


FIG. 4. STARTING AND SHUTTING DOWN CURVES SUGGESTED FOR A 12,000-KW. TURBO-GENERATOR

These simple tests showed up sharp differences. Since warming up and frequent starting caused injury to the stuffing-boxes and since one of the turbines under test had a crooked shaft and wheels, the starting code shown in Fig. 1 was worked out for the operators and is now closely observed. The turbine is now warmed only when running. The most favorable speed for the warming up period is 10 per cent of the normal operating speed, this figure being obtained from testing 17 turbo-generators.

Operating curves taken during closing down periods on still other turbo-generators were used to determine conditions of control valves, condensate and switching valves, oil and bearings, which curves are important for use in possible repairs. The curves shown in Fig. 2 were taken during the closing down period of a 6000-kw. turbo-generator operating at 1000 r.p.m. Lines *c* and *d* indicate increased friction as the turbine stops revolving. Investigations of the bearing showed that the white metal had deteriorated or corroded due to bearing currents. The line *c* in Fig. 3 indicates increased ventilating losses. Investigation showed that the exhaust valve was leaking.

It is important that the starting and warming up conditions of turbo-generators are accurate, considering especially machines that start and shut down twice a day, and that operate under peak loads and low loads. Systematic recording of operating conditions, especially starting and closing down, and eliminating warming up, and entrance of stuffing-box steam while the turbine is at rest, has proved to be of great advantage. It is suggested that the old rule of warming turbines 15 min.

before starting be abolished. Figure 4 shows a starting curve A and a closing down curve B suggested by Thyssen for a 12,000-kw. turbine of 3000 r.p.m., built in 1921. Tests on 17 turbo-generators have shown this curve to be correct.

Effect of Blending Gasoline with Benzol

DISTORTED DIAGRAM PERMITS OF READY DISCERNMENT OF KNOCKING ACTION IN INTERNAL COMBUSTION ENGINES. BY C. W. STEVENS

IT IS an established fact that most of the high grade motor fuels are blends of gasoline with varying amounts of benzol. Benzol has the property, when blended with gasoline, of eradicating fuel knocks, as well as benefiting the gasoline in other respects. It is hard, however, especially for a layman, to make any distinction between the appearance of blended and unblended fuels.

Knocking and the absence of knocking are indicated in Figs. 1 and 2 by the jagged edges or smoothness of lines respectively at the top of the diagrams. These cards were taken on a standard make of passenger automobile engine by means of a Midgely "optical" indicator which traces the diagram on a photographic plate

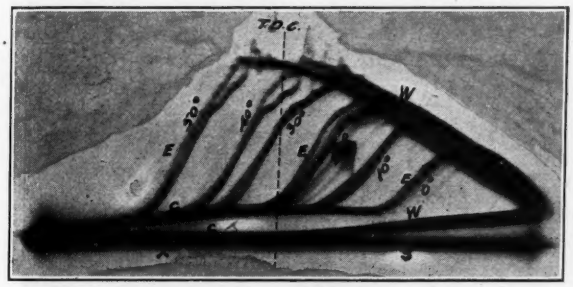


FIG. 1. DISTORTED DIAGRAM INDICATING "KNOCKING" WITH ADVANCED SPARK WHEN STRAIGHT GASOLINE IS USED

by means of a beam of light which is deflected so as to indicate the pressures in the cylinder for corresponding piston positions of the stroke. The vertical distances represent, to proper scale, the pressures per sq. in. in the cylinder at the given point; the length of the card represents the stroke of the engine, hence relative points on the card represent corresponding stroke positions.

To show more clearly what takes place during the explosion, the movement of the drum of the indicator is advanced 90 deg. ahead of the movement of the engine piston so that instead of representing only a very small movement during the time of the explosion, because this takes place at the end of the stroke, the drum is made to move at its fastest speed at this time, thus spreading out the diagram during the rapid rise of pressure in the engine cylinder. Such diagrams are called "distorted" or "out of phase" diagrams.

Figure 3 has been added to illustrate the appearance of the card which would normally have been obtained with a gas engine indicator if the engine were running at a low enough speed. In all three diagrams the principal events: suction, compression, explosion, expansion or working, and exhaust, are indicated by the corresponding letters S, C, E, W, and X. Because of the small difference in pressure, the suction and exhaust strokes appear in Fig. 3 as having the same pressure. These cards were taken at full load at 800 r.p.m. The best possible mixture and adjustment of carburization was used. The spark was advanced 10 deg. each consecutive run as indicated in Figs. 1 and 2.

Action resulting from the use of straight 68—70 Beaumé gasoline is shown in Fig. 1. As the spark was advanced beyond 20 deg. the explosion lines became more wavy. This waviness became most marked at

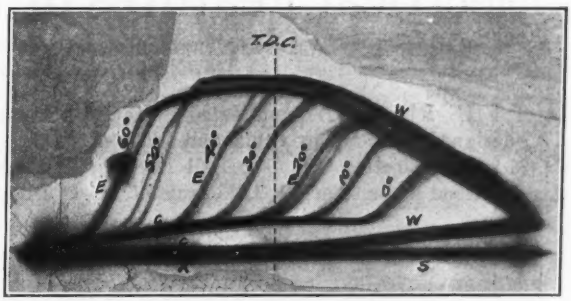


FIG. 2. DISTORTED DIAGRAM INDICATING ABSENCE OF KNOCKING WHEN GASOLINE IS BLENDED WITH BENZOL

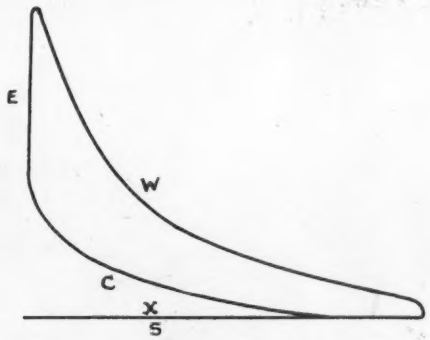


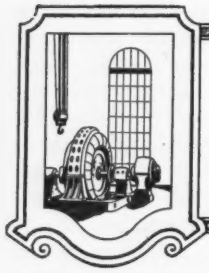
FIG. 3. DIAGRAM ILLUSTRATING NORMAL "CARD" FOR 4 STROKE CYCLE GASOLINE ENGINES

about 40 deg. advance where the line is shown to be jagged indicating premature explosion or "knocking." The "top dead center" is indicated at "TDC" by the vertical dotted line. Having these pictures of "knocks" before us, the apparent method of their elimination is that of retarding the spark to such an angle at which no waves appear.

Addition of 75 per cent of benzol to the 68—70 Beaumé gasoline eliminated the knocking. This is indicated by the absence of waviness in the explosion lines in Fig. 2 even when the spark had been advanced so much as 60 deg. while with the straight gasoline, the knocking became so bad at 50 deg. advance that it was not thought advisable to attempt advancing it further.

Modern Power Plant Trends

IN THE TABLE on page 4 of the January 1, 1927 issue, design and engineering of both Fordson and Iron Mountain plants should have been credited to the engineering department of the Ford Motor Co.



ELECTRICAL MACHINERY FOR LIGHT AND POWER

Electrical Features of a Modern Draft System*

A Description of the Unusually Flexible Draft Control System at the Somerset Station of the Montaup Electric Co.

AT THE RECENTLY completed Somerset Station, designed and built by Stone and Webster, Inc., for the Montaup Electric Co., near Fall River, and which was described in the April 1, 1925 issue of Power Plant Engineering, there is installed an unusually flexible draft control system. This was required in order to permit possible future modifications. The initial installation consists of manual combustion control for three oil burning boilers, one equipped with air preheaters and two without air preheaters, but designed for their addition in the future. Provision for future full automatic combustion control of these boilers burning oil or modified to burn pulverized coal was also necessary.

Three 1492-hp. Stirling boilers and one 32,000-kw. turbine-generator are included in the present installation, but the building is large enough to accommodate six boilers and two generating units. The forced and induced draft fans are both located on the fan floor above the boilers. This location of the forced draft fans was selected as it permitted a simple connection to the air preheater inlet and provided easy access to a plentiful supply of air from outdoors. The auxiliary switchboards providing power for the fan motors are centrally located between each group of four boilers at a grade 10 ft. above the fan floor, one fan switchboard being provided for the control of every four boilers.

FIG. 1. INDUCED DRAFT FAN, 150 HP. BRUSH SHIFTING MOTOR WITH ROTOR TRANSFORMER AND PILOT MOTOR CONTROL DRIVE WITH GEARING FOR SHIFTING THE MOTOR BRUSHES AND MOVING THE DAMPER. AT THE LEFT IS THE FORCED DRAFT FAN

The draft system consists of two 30,000-c.f.m. Sturtevant forced draft fans and one 110,000-c.f.m. Sturtevant multivane induced draft fan per boiler. Each forced draft fan is driven by a General Electric type BTS, 40 hp., 1800 r.p.m., 2200-v., 3-phase, 60-cycle, brush shifting motor, and each induced draft fan is driven by a General Electric type BTS, 150 hp., 720 r.p.m., 2200-v., 3-phase, 60-cycle, brush shifting motor. The type BTS, or brush shifting alternating current variable speed motor with a series characteristic, was selected to drive

*Prepared by Stone & Webster, Inc.

the fans after an investigation revealed that the greater initial cost of this type of motor was justified by its flexibility, high power factor and efficiency, particularly at reduced speeds and horsepowers.

Brush Shifting Motors Used

Alternating current motors for station auxiliaries with units larger than 25 hp., operating on 2200 v., were found to give the most economical installation. The slip ring induction motor was the lowest in initial cost, but for operation at reduced speeds and horsepowers, the power factor and efficiency would have been poor compared to the power factor and efficiency of the brush shifting motor. The brush shifting motor has further advantages in that it will operate above synchronous speed and give a smooth speed variation curve over the entire range which is preferable to fixed steps obtained by settings on a secondary resistor. These make the brush shifting motor particularly adaptable for automatic combustion control. Omission of the bulky secondary control necessary for a slip ring induction motor also saved considerable floor space and prevented congestion of the equipment on the fan floor.

The brush shifting motors operate over their entire speed range with a star connected primary or stator, eliminating any change of primary connections from star to delta, with the resultant momentary disturbance in the draft conditions during the transition period in which the brushes are being readjusted for the new connection. Omission of this change in primary connections entailed a slight reduction in power factor and loss in efficiency over a portion of the speed range, but eliminated two 2200-v. contactors ordinarily required for making the change, and allowed the motor primary to be directly connected to a solenoid operated primary oil circuit breaker. Each motor is equipped with a circuit opening speed limit device connected to the undervoltage relay tripping its primary oil circuit breaker. The speed limit device is supplied because the brush shifting motor operating without a change of primary connections requires a larger rotor transformer than it would otherwise, and the speed of the motor is not limited to a safe value by magnetic saturation of the transformer. The characteristics of the forced and induced draft fans and fan motors as determined by actual test for various loads and speeds are given in the table.

The minimum stable speed at which the motors will operate is approximately 30 per cent of their full load speed. The low values of speed and horsepower given in the tables, particularly for the forced draft fan motors, will not be used but are included to show the characteristics of the motors at these figures.

At present the fans are controlled manually from the firing aisle of the boiler room through the medium of combustion control equipment supplied by the Bailey Meter Co. The Bailey combustion control equipment for each boiler consists of two pilot motor control drives located on the fan floor and the necessary control equipment mounted on the boiler gage board. One control drive governs the speed of the induced draft fan and position of its damper, and the second control drive governs the speed of the two forced draft fans and dampers. The pilot motor control drives are adjusted from push buttons on the boiler gage board, and the control drives change the position of the fan motor brushes and dampers by means of steel shafting equipped with drive sprockets and chains. The forced and induced draft fans with their respective dampers may be operated either individually or collectively from push buttons on the boiler gage board. Each forced draft fan motor is equipped with a cam which enables the motors to be started and brought up to part speed without opening the damper. This provision was made in order to parallel a fan with one already running. The second fan can be started, its speed increased and the damper then opened, allowing it to be paralleled with the first or previously running fan with little disturbance in the draft system.

All fan controls are electrically interlocked with each other and with the fuel oil supply in such a manner that the induced draft fan must be operating before the fuel oil can be turned on, or before the forced draft fans can be started. This interlock allows either or both of the forced draft fans to fail and the boiler to continue in operation, but failure of the induced draft fan immediately stops the forced draft fans and discontinues the fuel oil supply, thereby eliminating the building up of pressure and the accumulation of oil vapor in the boiler setting. The combustion control system may be changed from manual to full automatic control by installing a master controller connected to the main steam header, the addition of control contacts in the gages and meters, minor modifications of the drum control switches on the boiler gage board, and a control drive for the fuel oil valves.

CHARACTERISTICS OF FORCED AND INDUCED DRAFT FANS AND MOTORS

Forced Draft Fan Motors										
With Air Preheaters				Fan Characteristics		Without Air Preheaters				
Speed	Hp.	P.F.	% Eff.	Draft In. of Water	Cu. Ft. Air Per Min.	Draft In. of Water	Speed	Hp.	P.F.	% Eff.
1760	40	98	86.5	5.0	30,000	3.5	1545	30	94.7	85.2
1420	24	89.3	83	3.65	25,000	2.6	1310	18	80	80.5
1170	13.5	69.5	76.2	2.55	20,000	1.9	1060	10.5	61.5	72.6
915	7	47	65.5	1.7	15,000	1.325	860	5.5	44	62
690	3.25	34.5	49.3	-	-	-	650	2.75	31.5	46

Induced Draft Fan Motors										
With Air Preheaters				Fan Characteristics		Without Air Preheaters				
Speed	Hp.	P.F.	% Eff.	Draft In. of Water	Cu. Ft. Air Per Min.	Draft In. of Water	Speed	Hp.	P.F.	% Eff.
614	149	100	87.5	5.5	110,000	4.0	730	133	99.5	87.1
530	78	93.5	83.9	3.7	85,000	2.7	565	70	88.5	82.3
370	19	53	66.2	1.5	50,000	1.05	332	16	50	63
252	8	36	51	.75	34,000	.5	252	6.5	34	46

Figure 2 shows the boiler gage board from which the fans are controlled, a steel panel 96 in. high by 72 in. wide. Mounted at the top center is a nine point Bailey indicating draft gage. An ammeter for one forced draft fan and an ammeter for the induced draft fan are mounted in the upper left-hand corner, and in the upper right-hand corner is an ammeter for the second forced draft fan and an oil pressure gage which will be replaced by an ammeter for the primary air feeder when the present fuel oil burning equipment is replaced with a pulverized coal combustion system. A Bailey boiler meter with steam flow—air flow indicators and recorders, and two multi-pen temperature recorders are located in the center of the gage board; above the middle recorder a white indicating lamp is installed to denote whether the pilot motor bus supplying the control drives is alive. Below the Bailey meter and temperature recorders are located from left to right,

in the order named, a control switch with indicating lamps, a drum switch and one blue indicating lamp for one forced draft fan; a drum switch, one blue indicating lamp and a control switch with indicating lamps for the induced draft fan; a control switch with indicating lamps, a drum switch and one blue indicating lamp for the second forced draft fan; a Dean valve control station, closing only, with four indicating lamps to denote the position of the boiler lead and non-return valves. Beyond the valve control station the board has been drilled and buttoned for the future primary air feeder control switch and indicating lamps. Beneath the electrical controls and in the center of the board is a

FIG. 2. BOILER GAGE BOARD

hand-wheel for manual regulation of the fuel oil supply. A fused control switch mounted at the rear of the gage board permits rapid and easy disconnection of the Bailey drum switches and push buttons from all voltage when it is necessary to work on the rear of the boiler gage board.

Blue indicating lamps, one for each fan motor, denote when lighted that the motor brushes are in the starting position. Electrical interlocking prevents the starting of any fan motor unless the brushes are in the correct position, as an undesirably high starting current might otherwise result. The fan brushes are, at present, quickly brought to the starting position by means of push buttons on the Bailey drum switches; but in the future, when full automatic control is installed, the motor brushes will be automatically returned to the starting position whenever power to the motors is interrupted, whether purposely or by means of the protective equipment. The drum switches for the two forced draft fans are duplicates, each drum switch consisting of a brass face plate mounting a three position switch with an indicating handle, and two push buttons, one marked "More" and the other "Less." The first, or "off," position of the handle entirely disconnects the variable speed control of the fan motor. The second position allows the fan motor speed to be varied by means of the two push buttons, and the third position transfers the control of the fan motor speed to the center or induced draft fan drum switch for collective operation of the fans. The drum switch for the induced draft fan consists of a brass face plate mounting a four position switch with an indicating handle, and two push buttons, one marked "More" and the other "Less." The first position of the handle is the "off" position and disconnects the variable speed control of the induced draft fan motor; the second position allows variable speed control of the induced draft fan motor from the push buttons; the third position permits control of both forced draft fans collectively from the push buttons; the fourth position permits collective control of the two forced draft fans and the induced draft fan from the push buttons. The third and fourth positions permit collective operation of the forced draft fans only when the forced draft fan drum switches are in position three, which transfers control of these fans to the induced draft fan drum switch.

Speed of Fan Motors Controlled by Push Buttons

Speed of the fan motors is varied from the push buttons on the drum switches through the medium of pilot motor control drives. The pilot motor control drive is the heart of the combustion control system. Each boiler is provided with two control drives, one for the two forced draft fans and the other for the induced draft fan. The control drive for the forced draft fans consists of a continuously running pilot motor driving a mechanism in connection with which is provided three pairs of solenoid-operated clutches.

Only two pairs of clutches are used for manual control, one for each fan and its damper, the third clutch being provided for future steam pressure control to facilitate changing to automatic operation. Each clutch is provided with mechanical travel limits adjusted for the individual fan motor, and with time limits to prevent runaway in case of voltage failure, short circuit or other abnormal conditions.

While the motor is protected against overspeed by a speed limit device, this equipment is of the hand reset type and the automatic limitation of speed without tripping the speed limit device on the motor is a very desirable operating feature. The solenoid-operated clutches are controlled from the push buttons of the drum switches on the boiler gage board.

Energizing the clutch solenoids transmits motion in the proper direction to increase or decrease the fan motor speed from the continuously operating pilot motor driven mechanism to a sprocket. This sprocket transmits its motion through chains and a set of shafting to another sprocket on the fan motor frame which moves the motor brushes and the damper by means of a specially designed cam. The cam allows the motor to be started and brought up to part speed before the damper begins to open and in stopping, permits the damper to be closed before the motor is stopped. The

pilot motor control drive for the induced draft fan is similar to that for the forced draft fans, but is provided with only two pairs of solenoid-operated clutches. This control drive also has a suitable gear ratio for operation in conjunction with the forced draft fan control drive to allow the induced draft fan to lead slightly when an increase in output is required and to lag slightly when a decrease in output is necessary. This will maintain a slight suction in the furnace at all times when the induced and forced draft fans have their speeds changed under collective control. The pilot motor control drive for the induced draft fan is complete for automatic control by steam pressure and by steam flow—air flow with no change whatever. Both pilot motor control drives are totally enclosed in metal cases supported about two feet above the floor.

The control switches with indicating lamps which are mounted on the boiler gage board are the General Electric standard twin pull oil circuit breaker control

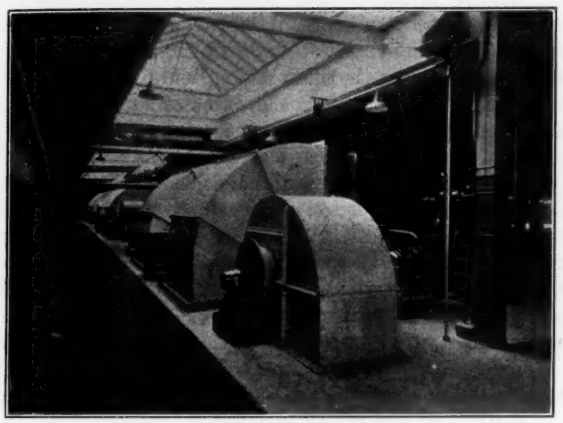


FIG. 3. GENERAL VIEW OF THE FAN ROOM

switches with a red and a green indicating lamp. These switches control the 2200-v. solenoid-operated primary oil circuit breakers which are a part of the fan switchboard. Each fan switchboard will ultimately consist of 16 panels. The switchboards are located in a room about 10 ft. above the fan floor, each panel being 90 in. high by 20 in. wide. Each switchboard is designed to control the three fans, and primary air feeder for each of four boilers, but only such panels are installed as are required for present operation. Each panel is also provided with a solenoid operated triple pole oil circuit breaker with the necessary disconnecting switches connected to a 2300-v. bus. One bus is provided for three fans and the primary air feeder for each boiler. Each bus is fed from an independent circuit, which greatly reduces the possibility of failure of the auxiliaries of more than one boiler.

Principles of Oil and Air Circuit Breakers

By Philip G. Bernholz

IN VIEW of the wide extent to which oil and air circuit breakers are used in practice it is somewhat surprising to know that considerable confusion exists in the minds of operators as to the operation of these two types of switches. The principle of operation of the oil switch is quite different from that of the air break switch and it is because of this difference in principle that oil switches are not used on direct current systems. When two contacts are separated while carrying current, an arc consisting of high temperature vapors is formed. This vapor is of relatively low resistance and allows the current to continue until the contacts are separated so far that the voltage of the circuit can no longer maintain the arc. Under oil, such an arc would be more confined than if it occurred in air, but it would not be reduced greatly in length. The oil break in this case has little advantage, particularly since there would be considerable danger from fire if the arc continued for any length of time. An air switch or circuit breaker can easily be equipped with a magnetic blowout which automatically stretches out the arc to the breaking point and if the voltage is not too high the current is almost instantly interrupted.

Magnetic blowouts are used in connection with air break switches on both direct and alternating current circuits, although their greatest application is with direct current circuits. With this arrangement the current is actually ruptured while flowing by being stretched out to the breaking point. The oil switch or oil circuit breaker does not actually break the circuit *while the current is flowing* and for this reason it has not found application in direct current work.

When two metallic contacts carrying alternating currents are separated under oil, arcs of metallic vapor are formed which force the oil away with more or less of an explosion, depending upon how much power is being interrupted. This arc or explosion is caused by the metal vapors while the current is flowing, but, since in an alternating current circuit the current goes down to zero before reversing, this vapor almost instantly condenses against the cold oil. Before the voltage builds up in the reverse direction, all the hot vapors have been condensed, leaving a vacuum, into which the oil rushes, thus blocking the current. At ordinary voltages the current continues for the remainder of the cycle on which it is opened but is interrupted at the very first time the current passes to zero. At extremely high voltages, however, it becomes impossible mechanically to separate the contact far enough in the first two cycles so that the final block or rupture occurs after one or more cycles. In air, an arc is not condensed anywhere near as quickly so that the hot gases remain between the contact even though the voltage passes to zero a number of times. Cold walls of porcelain greatly help to condense an arc and this has been taken advantage of in fuse blocks.

It is because of this difference in the action of air and oil circuit breakers that disconnecting switches should never be used for opening the circuit while current is flowing, as they are not designed for that purpose. Disconnects are provided to open the circuit after the oil switch that is in series with it has been opened. Under heavy short circuit, disconnect switches have been known to fly open, due to the magnetic force of the current through them. In such cases the damage to the switch is considerable. To avoid accidents of this nature, it has become a custom to provide disconnect switches with locks so that they cannot be opened except when the hook is pulled down prior to pulling them out.

Good Lighting Is Important for Safety

IN A RECENT address before the Industrial Accident Preventive Conference, by W. H. Rademacker of the Edison Lamp Works at Harrison, N. J., it was brought out that investigations of the Traveler's Insurance Co., studying 91,000 industrial accidents, showed that 23.8 per cent of those accidents could be traced either directly or indirectly to improper lighting.

This was in 1913, and since that time considerable progress has been made but it is stated that today a major factor in one out of every eight accidents is improper illumination.

In a study of industrial lighting by the National Electric Light Association committee, it was found that of 390 typical American industrial establishment, 29 per cent were fairly lighted, 56 per cent were poorly lighted and only 15 per cent were well lighted. Statistics also show that more accidents occur in industries during the winter months when daylight hours are few, than during the summer and that there are far more accidents during the hours of darkness than during the hours of daylight.

From these and other figures it would seem that industry as a whole has not yet appreciated the important relation between improved lighting and accident prevention.

No one would consider the chances good for a blind man to avoid accident, if unguided in the average factory. It is estimated that approximately 70 per cent of our muscular activities are a result of the sensation of sight, so that the safety of the worker is dependent almost entirely upon the ability of his eye to see quickly and surely. Unsatisfactory illumination, from the safety view point, may be the cause of inadequate quantity, or unsatisfactory quality. It is not unusual to find areas and active working positions in plants which are dark, gloomy or in harsh shadow because the light sources are too small or improperly located. Such conditions are likely to result in falls over unseen obstacles, or collision with unseen projections.

Desirable illumination, in foot-candles, has been specified in the code for lighting of factories and other work places by the Department of Labor of the state of New Jersey as follows:

Roadways and yard thoroughfares 0.05 to 0.25; storage spaces 0.5 to 1, stairways and passages 0.75 to 2; rough manufacturing 2 to 4; manufacturing involving some detail, 3 to 6; fine manufacturing such as pattern and tool making, 4 to 8; extra fine work such as watch making and engraving 10 to 15; office work, 4 to 8.

The values given above are in foot-candles. A lamp giving off 16 candlepower produces illumination of one foot-candle at a distance of 4 ft., the lighting effect varying as the intensity of the light source and inversely as the square of the distance from that source. The quantities of illumination found necessary for safety are far less than those necessary for efficient working, hence there is no economic excuse for insufficient lighting.

Unsatisfactory quality of illumination is usually due to what is known as glare. This is the sensation experienced by looking at an exposed incandescent lamp filament, which produces temporary blindness. Such illumination comes from improperly placed or improperly shaded lamps used in industrial plants and, if the sustained condition is allowed to continue, is likely to result in permanently impaired vision. Working with a glaring lamp in one's face, and then turning to a poorly-lighted area results in a condition of temporary blindness of the worker which may be the cause of almost any kind of an accident.

Five recognized causes of glare are classified, viz.: Excessive brightness of the light source; excessive volume of light shining into the eye; bad position of the light source; too great contrast between the light source and the back-ground; excessive time of exposure of the eye to the light source.

Proper lighting may be obtained by choosing the proper size and type of lamp which, if mounted so as to be in the line of vision, should be of the diffusing bulb type. An efficient reflector of proper design should be employed to throw the illumination where it will be most useful. Light sources should be so spaced as to avoid non-uniform or spotty light distribution and harsh shadows, a spacing between units which does not exceed their height above the floor being found to give best results. Walls and ceilings should be of such color that they do not give excessive contrast between surrounding areas and light sources, also should not absorb light as is the case with dark surroundings. Cleaning and maintenance should be on a regular system which prevents the lighting unit from becoming excessively dirty and insures that they are promptly replaced when burned out. Immediate replacement and a schedule of cleaning every four to six weeks is advisable in the average factory.

Values of foot-candle illumination absolutely necessary for safety are given as: For roadways, 0.02; storage spaces, 0.25; stairways and passages, 0.25; rough machining and bench work, 1.25; rough detail manufacture, 2; fine tool work, 3; watch making, engraving and similar work, 5; office work, 3. For satisfactory illumination the foot-candles suggested are: For rough work, 4 to 6; average work, 6 to 10; and fine work, 10 to 16 and the corresponding required watts per sq. ft. of floor area are: For rough work, 0.7 to 1; for average work, 1 to 1.6; and for fine work 1.6 to 2.5.

Electrically Operated Earth Mover

Used in Construction of the Philbrook Dam of the Pacific Gas & Electric Co.

IN THE construction of the Philbrook dam of the rolled earth-fill type, recently completed for the Pacific Gas & Electric Co. on a branch of the west fork of the Feather River, 15 mi. above Sterling City, Buttee County, the contractor, The Kaiser Paving Co. of Oakland, used a new type of power-scraper, named the "Earth Mover."

This earth mover with caterpillar track is different in design and principle of operation from anything ever before developed for scraping or moving earth. It represents a complete departure from accepted practice. It is unique in that although it is for extra heavy work and has great capacity, it is entirely controlled by the

driver from the tractor and no extra operator is needed. It is operated by electric motors driven from a generator mounted on the tractor, the motor controls being at the driver's hand.

This combination will hold up on soft ground or sand and has great capacity. The tool proper is in four telescopic sections and carries 12 cu. yd. of earth when filled. The telescoping scoops are mounted on a rack and pinion device so that they can be pushed back one after the other, propelled by an electric motor, as previously mentioned and controlled by switches at the tractor driver's hand, the current being derived from the special generator on the tractor. Two controls are operated separately—one expands or telescopes the sections—the other tilts the whole assembly so that the front end or blade will cut deep into the ground or scoop or dump the load.

At the forward end of the frame and fastened to it, is a bucket approximately 7 ft. wide, 3 ft. high and 3 ft. long, having no back in it. This bucket is lowered into the ground and raised at the will of the operator, by the electric motor, controlled from the driver's seat. In addition to this bucket which is rigidly fastened to the frame are four other buckets without any backs in them, which fit snugly inside of the first one so when folded up there appears to be but one laminated bucket. When this bucket has scraped up a load, the top leaf slides back, thus exposing the next leaf which receives its load while the next one is receding. This recedes until its front end rests on the back end of No. 4 bucket and then picks up No. 4 and takes it along with it. Thus the two buckets continue in this backward motion, thereby exposing No. 3 which begins to receive its load, and so on until the front end of No. 2 rests on the back end of the stationary, or No. 1, bucket. When fully loaded, the machine again appears to have but one bucket but now is 15 ft. long instead of only 3 ft., as when the loading was commenced.

To unload, the action is simply reversed. No. 2 slides into No. 1 first, thus pushing the dirt out of No. 1 bucket while the blade which is fastened to No. 1 is set at the desired spreading elevation. Then No. 3 slides into No. 2 thus emptying No. 2 and so on. When the last bucket reaches its forward position inside the other buckets, the tail gate slides through it emptying the entire load. It is then returned to the rear end of No. 5 bucket, leaving the machine ready to load again. Less than a minute is required to pick up a 10-yd. load and the 60-hp. tractor can use its highest speed in transporting the load. Owing to the fact that the tractor is narrower than the gage of the track on the earth mover the entire width of the layer of earth is packed hard.

ELECTRICALLY OPERATED EARTH MOVER HAS TELESCOPING SECTIONS

Patent Rulings May Affect Choice of Equipment

A Discussion of the Rights and Liabilities of a Power Plant Owner in the Use of Patented Equipment. By Leo T. Parker

IN VIEW of the numerous previously decided cases which involve all phases of patent litigations, a valuable and informative interpretation of the rights and liabilities of power plant owners, who purchase and use patented appliances, is readily obtainable.

One of the most frequently asked questions is: "May the purchaser of a patented device use it freely and unrestricted without liability?"

For example, in a quite recently decided case it was disclosed that the manufacturer of a patented machine prevented purchasers from utilizing it in combination with equipment made by other manufacturers. On the face of the situation it seems that such a restriction violates the anti-trust laws. The Courts, however, consistently hold that a patent is the most perfect form of monopoly in existence, because a patent gives its owner the right to exclude all other persons from making, selling or using it. Moreover, it has been held that the rights of a patentee extend considerably further than the mere right to make, sell and use the invention.

In the following paragraph which is an extract from a recent United States Supreme Court decision are explained the rights of both the purchaser and seller of a patented article:

"The unconditional sale of a patented article carries with it the right to use it in any way that the purchaser chooses to use it, unless he knows of restrictions or they are brought to his mind at the time of the sale. He is bound by them on this principle: The patentee has a sole right of selling and using the articles, and he may prevent anybody from dealing with them at all. Inasmuch as he has the right to prevent people from using them or dealing in them at all he has the right to do the lesser thing. That is to say, to impose his own conditions. It does not matter how unreasonable or how absurd the conditions are."

In other words, patentee may restrict the uses to which his invention shall be put, if these restrictions are brought to the attention of the purchaser.

Recently, however, a court in effect said that the general rule is that if a patentee unconditionally sells a patented invention, the buyer acquires the right to use the machine without restrictions, and furthermore when such machine is lawfully made and unconditionally sold, the machine passes without limitation or restrictions and the patentee cannot later restrict its use in any way.

Another recent decision, by the United States Su-

preme Court, held that the patentee of a machine may if he desires go so far as to specify the kind of materials which the purchaser shall use or make in it.

In another case, however, the same court pointed out that the owner of a patent cannot control the price at which a dealer or other person shall resell a patented article, even though a contract exists between the patentee and the purchaser which stipulates that the device shall not be sold at less than a price fixed by the patentee.

In still another case the court in effect said that the holder of a patent has the exclusive monopoly to the uses and benefits of the invention. Further, that while an inventor, who fails to obtain a patent, may be deprived of the monopoly if another person is diligent and obtains a patent so that the public may be benefited, yet at the same time after a patent is issued its owner is privileged to license other persons to make and use the invention, or he may refuse to market or permit others to market it.

It is true that this phase of the law is somewhat different in various foreign countries, because in some places an inventor is compelled to manufacture or permit others to make his invention, so that the public may be benefited within a specified period of time after the patent is issued, otherwise he loses his rights to the patent. Not so in this country. The owner of a patent may pigeon-hole it if he so desires, and thereby prevent any person or firm from benefiting from the invention, for the full term of seventeen years.

Another common question, that bears discussion with power plant owners, is whether or not a person who purchases a patented invention in good faith and obtains it from a reliable manufacturer, is liable for damages to a person who holds a basic patent on it unbeknown to the manufacturer who made and sold it.

In a recent litigation wherein this point of the law was involved the court held a user liable for infringement and in effect said that the inventor is to have the exclusive right to make, sell and use the invention, therefore it is immaterial whether or not the purchaser and user of an infringing device obtains it from a manufacturer who believes no infringement exists. Moreover, in cases of this kind the patentee or owner of the patent is privileged to sue and recover damages, as well as the total profits earned by the manufacturer. He may also ask the court to confiscate all of the inventions which are now in unauthorized course of manufacture, and those which power plant owners may have purchased in good faith from manufacturers who made them without knowledge or suspicion that infringement exists.

Purchasers of mechanical equipment may, however, contract with the seller to be relieved of the expenses of patent litigation, or other losses which may occur as a result of purchasing and using equipment, or using processes licensed by a manufacturer or other person.

When it is considered that all purchasers and users of inventions may be liable for infringement, whether the act is done innocently or purposely, it is easy to realize the importance of including in all contracts for the purchase of equipment, the following paragraph or clause:

"It is thoroughly understood between the seller and purchaser of the herein referred to equipment, that the seller shall relieve or reimburse the purchaser of all expenses of litigation or legal controversies of patents which may result from the use, or purchase, or otherwise, of the herein mentioned equipment. Furthermore, the seller agrees to advance to the purchaser all necessary or fairly estimated expenses or money, or both, required to carry on litigation or defend against a suit, or other proceedings, which may result or be caused, should any person or firm institute legal proceedings against the purchaser to prevent said purchaser from utilizing the herein mentioned equipment, or to compel said purchaser to pay royalty or other form of rental for maintaining, retaining or using said equipment. It is further agreed that the seller shall reimburse the purchaser and save the purchaser from all loss and expenses caused by litigation, or the like, wherein the patents of said equipment, or a part thereof is involved. And it is understood, further, that the purchaser is buying the herein described equipment from the purchaser in the belief that the seller is legally entitled to manufacture and sell said equipment without restriction or the likelihood of litigation, or suit, based upon patents which may exist presently, or which may be issued at some future date."

The importance of including this clause in all contracts which relate to the sale of equipment may be fully realized when it is considered that a non-infringing machine or device of today, may be an infringing one tomorrow. Because so long as an inventor has received no patent, he is not possessed of power by which to appeal to a court to prevent the unauthorized manufacture, sale or use of his invention. And at the time equipment is purchased no patents may then be granted on it, but if one is later issued the patentee may immediately prevent further use, or demand damage or royalty from persons and firms who have purchased the equipment previous to the granting of the patent.

Various important and valuable patents have remained unissued and in controversy in the Patent Office for several years unknown to persons and manufacturers, all because none but the Patent Office officials may know of patents which are pending. Later when one of these dormant patents is issued, the patentee is possessed of means by which he may legally prevent further use of the inventions which have previously been manufactured and sold.

For example, a well known and important patent remained unissued in the Patent Office for a period of more than 15 yr. Many manufacturers were engaged in making and selling the invention. After the patent was issued, the inventor instituted legal proceedings against the various manufacturers and users to compel the payment of royalties for the mechanical creation arising from his brain, and by which the different firms were profiting.

It is important to know that simply because a machine is marked "Patented" is not a good or absolute reason for a power plant owner to be assured that the inventor holds a basic patent on the machine. This is true because hundreds of patents may exist on the various parts of a complicated machine. Furthermore, as the inventor is not required to stipulate the kind or terms of the patent he possesses, there is no method of

knowing the field covered by the patent until one is secured and thoroughly and carefully read. Any person may obtain copies of patents by addressing "The Commissioner of Patents, Washington, D. C." Be sure to give the serial number of the patent, and send 10c for each copy desired.

As a matter of fact a design patent may be obtained on the exterior appearance of an article, and it may be marked "Patented." Under these circumstances no part of the mechanical equipment is patented, yet without obtaining a copy of the patent it is impossible to know just what part of the machine or device is protected. This phase of the patent situation, however, is not so important as the uncertainty with respect to the various applications for patents on a particular invention which may be lying in the Patent Office unissued at the time a complicated and expensive machine is purchased. For this reason if the above mentioned clause is included in all of the contracts of sale, the power plant owners actually may be relieved of the worry or need of investigations relative to the legal status of patented equipment.

Some distinction exists between mechanical and other patents such as process or composition, but it is important to know that the omission of any material part of the invention claimed, may entirely relieve the manufacturer or user of the product from liability as an infringer. This is a rule well established in the law of patents. So, therefore, while kind of patents may differ in form, the rules of infringement are similar in many respects.

For instance, it has been said that a new process generally is the result of discovery, while the creation of a machine is invention. An example of a mechanical process patent is one which describes a new method of casting cylinders. A gate is formed whereby centrifugal action is produced which causes the dross to flow toward the center of the cylinder and heavy iron is carried to the outer edge, thereby causing the outer surface of the cylinder to be free from imperfections. Generally speaking, any new process or method of doing something may be the subject of a valid process patent which actually consists of a series of steps or acts to advantageously accomplish a thing.

Although, the omission of a single one of the steps avoids infringement, yet simply because the order of the steps or acts is reversed or rearranged will not relieve a person from the liability of infringement.

A composition patent is one which relates to the ingredients used to make a product. For illustration, a composition patent was obtained on a certain well known boiler compound. It consists of a combination of chemicals which are mixed in a manner intended to produce the desirable effect of removing and preventing the formation of scale, but any person or firm may mix and use this patented preparation, if one of the ingredients claimed in the patent is eliminated or omitted.

Welding Saves Money for the Engineer

MANY REPAIRS AND PIPING JOBS ABOUT THE POWER PLANT CAN BE DONE QUICKLY AND EASILY BY WELDING. BY L. A. COWLES

ONE OF THE principal reasons why power plant engineers have not learned to use the welding torch is due to the fact that we have considered this a trade in itself. There has been so much said against the welding of pressure vessels with the torch that it has received a black eye as a power plant tool when the fact is, the engineer can, in a short time, become proficient in using both the cutting and welding torch and the welding of pressure vessels is the least use he has for it.

Cost of welding equipment is insignificant when compared with possible savings, an investment of $200 for equipment lasting at least 10 yr. This is a cost of only $32 a year, interest included. One cut into an 8-in. line for a 2-in. branch line, saving a flanged tee costing $19 and saving time for the steam fitter and helper amounting to $12.80, has paid for a year's use of welding equipment. This welded joint is leak proof, stronger, neater and has not increased radiation. Since only a small hole was cut through the pipe covering to make the joint, covering with insulating material was much easier with the welded joint, besides decreasing production loss by shortening the time out for the line.

There are many indirect savings, as the work connected with stopping a leak in a large pipe line or cutting into the line for a branch is heavy work, often requiring a number of men to handle it and is put off as long as possible, while the torch is light, easy to handle, the gas tanks are mounted on a hand truck easy to move, and 30 ft. of hose will reach almost any work.

As an illustration, a 6-in. steam pipe started leaking at an elbow, there was no union between the elbow and a tee and the pipe was 14 ft. long. To cut this line in two with a pipe cutter and put in a union was almost impossible, but by cutting it in two with the cutting torch, screwing the leaking end in as tightly as possible and welding the pipe back together again, we stopped the leak with comparative ease. Many are under the impression that it is impossible to weld around a pipe unless it can be turned so as to keep the operator working on top, this is not the case, as with a little practice the welding can be done upside down.

NEW PIPE LINES ARE NOW BEING WELDED

Fabrication of an entire piping layout with the cutting and welding torch, not using fittings of any kind except flanges welded on for connections to boilers, engines and pumps, is becoming quite common and has passed the experimental stage. Starting with 2-in. pipe it has been proved to be cheaper and the difference in favor of welding increases rapidly as the pipe size increases.

In addition to the advantages already mentioned for the welded joint, elbows, tees, crosses and Y branches, can be made on the job for less money. Also it eliminates the stocking of a great number of fittings, reduces the cost of gaskets and has a marked advantage in that odd angles and reducing fittings can be made up as needed without waiting for special orders to be made at a cost much above the welded connection. I have had this experience and saved $225 on one run of pipe connecting a centrifugal pump, as well as several days time

in fitting up the line, since the pipe was cut and fitted in place with the torch, leaving no strain on the pump connection. The cost of planning the layout was reduced to the minimum as with the oxy-acetylene equipment it was merely the consideration of the shortest distance between two points, the fittings not controlling the laying of the pipe. Cast-iron pipe is a little more difficult but can be done with the torch by brazing the connections, cutting being done with a cold cutter and a light sledge, nicking the pipe all round for a break. Of course expansion and contraction must be taken care of in the usual way with expansion joints.

Training an operator for the torch is not as difficult as might seem and it can not be considered an obstacle to the securing of the economies possible. I spent two days with a local welder who instructed me in using the welding torch and by practicing under his direction, I soon learned to handle it. I then secured several books on welding and found that by following the instructions

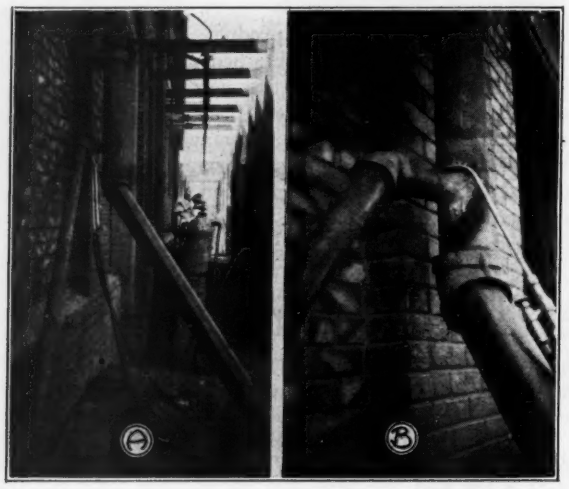


FIG. 1. ALTOGETHER IT REQUIRED A FEW SECONDS LESS THAN 5 MIN. TO CUT THE HOLE SHOWN IN A AND WELD THE 2-IN. PIPE SHOWN IN B

given, I did not need to pay out any more money for instruction.

Use of the torch in the power house has some characteristics of its own and the engineer-welder will secure better results than one not acquainted with his needs. Most of the trouble with boiler repairs by welding have been caused by really first class general repair welders attempting a repair which an engineer would know better than to try.

Fireman Does Welding Without Instruction

As I see it now, after using the torch for several years in the plant of which I have charge, it is part of the engineer's business to know how to reduce his costs of maintenance by repairing parts and fabricating piping with the welding equipment regardless of whether he intends to do the actual welding or not. The ease with which welding can be learned is illustrated by the following story. One of my firemen had broken the ashpit door and fearing a call down, decided he would weld it. He did, and the job was well done. He had watched me several times and had asked a few questions but outside of that had never had the torch in his hands. I did not approve of his having done this as there are some precautions one must take and I instructed him not to touch the torch again until he had studied the books, which I was more than pleased to loan him, and could pass an examination covering the fundamentals. This has resulted in a first class welder and relieved me of much of the work.

Many engineers will say they do not have time to spend in doing any thing more, but I have found that welding fits in as spare time work, and using the torch a short time so reduces time spent on repair jobs that much time actually is gained. I am really spending less time at the plant by doing in a month, emergency repairs which required a year's time when first taking charge.

FIG. 2. NEEDING A SMALL PIPE COIL, 18 IN. LENGTHS OF ¼-IN. PIPE WERE CUT, SIX HOLES WERE DRILLED IN TWO LENGTHS OF ½-IN. PIPE AND ¼-IN. PIPE WELDED INTO THE HOLES. ONE END OF EACH ½-IN. PIPE WAS CLOSED BY WELDING A KNOCKOUT PENNY FROM A CONDUIT BOX, AND AFTER TESTING THE SMALL RADIATOR WAS FOUND TO BE TIGHT AND WAS PUT TO WORK HEATING OIL FOR A FILTER

This is due principally to the fact that welded repairs are much quicker, often being made without removing the part, and they are permanent. A pit hole through a pipe line does not necessitate the replacing of the line. The removal of boiler tubes with the cutting torch requires only 30 min. without removing brick work as compared formerly with a day's work and the tearing down and replacing of all of the door arches and brick work below the front end of the tubes in horizontally baffled boilers.

A tube blister or pin hole is merely a moment's repair job with the torch, where before, the tube would have to be replaced besides necessitating the repair of the baffle around the tube removed. A broken fire tool does not call for several hours work over a forge, but a few minutes with the torch and the repair is made. At the present moment one of my repair men is taking down a boiler front, a hole having rusted through, caused by an occasional leak from a flange. We will cut out the rusted section and weld in a new piece; this

will save buying a new front, and that leaking flange is going to be brazed as several new gaskets have failed to stay tight more than a month or two.

Welding No Longer Dangerous

One reason welding equipment has not been more widely used in the plant is the prevailing idea that it is dangerous. This was true 15 yr. ago but is not the case now, as such improvements have been made in the storing of acetylene in cylinders and in the design of generators, regulators and torches that the danger is practically eliminated.

There are a few precautions to take, one being that no oil should come in contact with parts containing oxygen and the gas cylinders should not be subjected to heat. The torch will stand a tremendous amount of abuse, but the more carefully it is handled the longer it will last. It is a precision instrument, mixing the gases perfectly in the correct proportions to secure complete combustion. The strength of the weld depends to a great extent upon the flame adjustment. A neutral flame must be maintained at all time when welding steel and cast iron while in the brazing or welding of brass and alloys of brass or copper, an excess of acetylene is sometimes recommended.

The cylinders containing acetylene and oxygen are furnished by the manufacturers of these gases and usually a nominal rental charge is required, averaging 25 cents a month. The acetylene cylinder has been made safe by filling with a porous mass saturated with acetone, the latter taking up or giving off the acetylene. This point should be kept in mind that acetylene gas under more than 20 lb. pressure is dangerous. The least jar or vibration may cause an explosion unless contained in cylinders made for this purpose. Most of the present day torches have been made to keep this pressure as low as possible, torches operating with a pressure of less than 10 lb. being practically the only ones in use.

In addition to reducing valve, hose, torch flux and welding rods, a welding table, a few iron clamps, some asbestos, carbon rods and carbon paste, an emery wheel is about all that is needed. A complete outfit can be purchased for \$175 to \$250, the price depending upon the quality, size torch and number of tips. A combination cutting and welding torch can be purchased or separate welding and cutting torches, as desired. I have never used the combination torch and so cannot speak from experience.

Hydraulic Turbine Tests by the Gibson Method

Demands of Accuracy and Convenience Met by Method Based Upon Two Fundamental Laws of Physics, Applied to Flow in Closed Conduits. By Norman R. Gibson*

MEASURING the flow of water in closed conduits by the Gibson method is based on two of the fundamental laws of physics. Its success in precision work is due to the absence of empirical coefficients, making its accuracy dependent only on the design of the instrument and the precision with which certain lengths and areas may be measured. The simplicity of application as well as its accuracy has made it very useful in testing the efficiencies of hydraulic turbines and in rating hydro-electric units.

Laws on which the method is based are Newton's second law of motion, known as the law of impulse and momentum, and the law attributable to Joukovsky regarding the pressure wave in a closed conduit due to a retardation of velocity. Without discussing fully these principles and their direct relations to the apparatus, the two conditions necessary for the application of this method are a closed conduit or pipe supplying water to the turbine and a means of stopping the flow readily, as may be done by the turbine gates. The record of pressure rise which occurs during the gate closure is called the "pressure-time" diagram, and when properly interpreted or delineated, as in Fig. 1, is a direct measure of the momentum of the water column immediately before the shut-down.

Knowing the physical dimensions of the penstock or water conduit and the calibration constant of the instrument, the quantity of water flowing may readily be obtained. That is, a definite quantity of water flowing in a given conduit has a definite momentum which is directly proportional to the velocity or the quantity of water flow. The impulse due to the destruction of this momentum, which takes place when the turbine gates are gently and gradually closed, is a measure of the quantity of water flowing.

Apparatus designed for this purpose is shown in

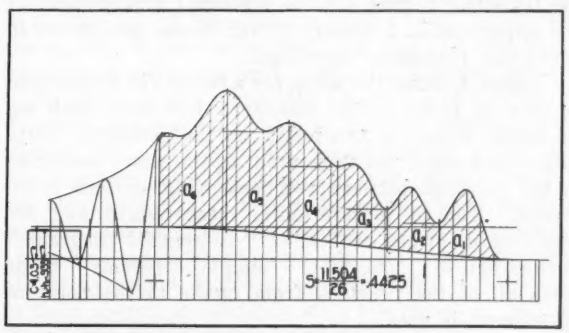


FIG. 1. THE TIME-PRESSURE DIAGRAM FORMS THE BASIS OF CALCULATION

cross section in Fig. 2 and consists of a mercury U tube connected to a camera box containing a lens focused on a cylinder in a light proof case. This cylinder carries the film upon which the pressure-time diagram is recorded. One leg of the U is a glass tube of uniform bore and the other a steel riser also of uniform section. The glass tube is of suitable length for the travel of the lower mercury surface and the ratio of areas of glass and riser is properly selected for the impulse or momentum to be measured. Time lines are plotted on the film by means of a seconds pendulum intercepting the light as the pendulum swings in front of the lens. The drum holding the film is revolved by a constant speed spring motor, the speed of the film being adjustable by a governor on the motor and the size of the driving pulley.

*Consulting engineer, Niagara Falls, N. Y.

Placed in front of the glass tube containing the lower mercury surface is a Cooper-Hewitt mercury lamp. The light passes through the water above the mercury column but is stopped by the opaque mercury, thus making a sharp image on the film. When the shut-down occurs the film is rotating and takes a motion picture of the mercury oscillations with time plotted as abscissae and mercury displacement as ordinates. The U tube is connected to the penstock with a ¼-in. piezometer opening at a point conveniently near the turbine. Figure 3 gives a general arrangement of the apparatus in a modern power house, and shows in detail the piezometer openings.

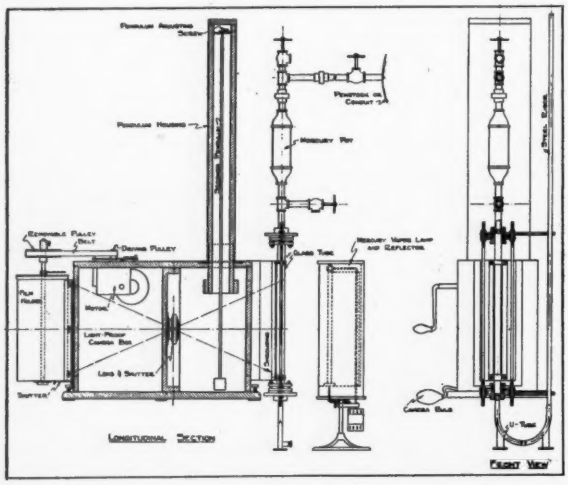


FIG. 2. CONVENIENT ARRANGEMENT OF ALL EQUIPMENT IN A CABINET IS A FEATURE OF IMPORTANCE

Figure 4 shows the setup for a test. The U tube can be seen in front of the mahogany box, with each leg connected to one of two points on the penstock. With this arrangement the momentum of the water contained in the penstock between two measuring sections is recorded. This is a differential measurement and the resulting diagrams are called "differential diagrams" to distinguish them from "simple diagrams" made when all of the penstock from intake to the point of attachment is used.

When proceeding with a test, the physical dimensions of the interior of the penstock between the measuring sections are obtained either from design drawings, from actual measurements or both. From this data may be obtained the pipe factor, a constant which takes account of the physical dimensions of the conduit. Prior to the date of the test the apparatus is set up and its calibration secured by determining the ratio of mercury travel in the glass tube to that in the steel riser. The inverse of this ratio gives the ratio of tube areas from which is determined the calibration constant, K, of the instrument.

Usually the personnel selected is taken from the engineering and operating staffs of the power company and is directed by one man who acts as supervisor of all operations. Observers are stationed at the headwater gage, tailwater gage, gate-opening recorder and piezometer for measuring the net head at entrance to the turbine casing. One operator is required for the Gibson apparatus. Several observers are necessary for the electrical readings and one of the plant operators operates the governor for controlling the turbine gates.

The operator of the apparatus has from 6 to 10 film holders or light proof cylinders which are used successively for the various runs of the test. Each film holder is "loaded" with a film 11 by 18 in., the film being wrapped around and securely fastened to an internal cylinder which revolves on ball bearings set in the holder. With this equipment in readiness, one film holder is slipped in its place on the back of the camera box of the apparatus, and the driving shaft of the internal cylinder is connected to the driving mechanism. The lens shutter is set, the shutter of the film holder is opened, and the Cooper-Hewitt lamp in front of the glass tube is lighted.

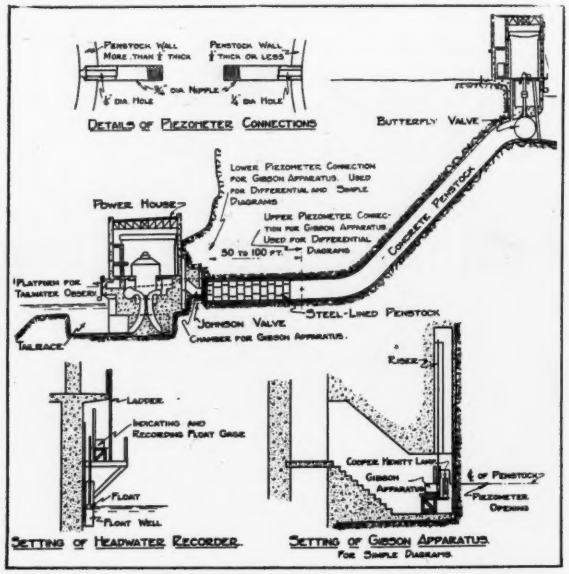


FIG. 3. PIEZOMETER CONNECTIONS DEPEND UPON THE TYPE OF PENSTOCK AND WHETHER THE SIMPLE OR DIFFERENTIAL DIAGRAM IS TO BE USED

When everything is in readiness for the test the unit to be tested is synchronized with other units in the plant and run on steady load at the desired point with the gates fixed for several minutes. In fixing the gates at the various percentages of gate opening where it is desired to determine the efficiency, it is important to have them perfectly steady so that disturbances will not be set up in the penstock. For this purpose the hand control, which is usually supplied on a modern governor, is used.

At a given signal, controlled by the operator of the Gibson apparatus, the several observers begin to read their instruments. Observations are taken of the headwater and tailwater levels, piezometer for net head measurement, gate opening, kilowatt output of the generator, volts and amperes of exciting current, and the usual entries of time, etc.

After these observations have been made for a period of two minutes, the operator of the apparatus puts this instrument in motion and gives another signal at which all the observers mark their records and the governor attendant gradually and gently closes the turbine gates.

The duration of closure varies from 5 to 40 sec. depending on the gate opening and the hydraulic layout of the unit being tested.

As the turbine gates close, the power output of the unit diminishes and its load is picked up by the other units which are operating in synchronism with it. When the gates are fully closed the unit continues to revolve at normal speed, being then operated as a synchronous motor.

Closing the turbine gates in this manner is to produce a change of pressure in the penstock which occurs when the flow of water is brought to rest. This is recorded by the apparatus, in the form of a pressure-time diagram with pressures as ordinates and time measured as abscissae. The measurement of time is accomplished by the seconds pendulum which swings in front of the lens and intercepts the light every second and which is set in motion by a release operated in synchronism with the lens shutter.

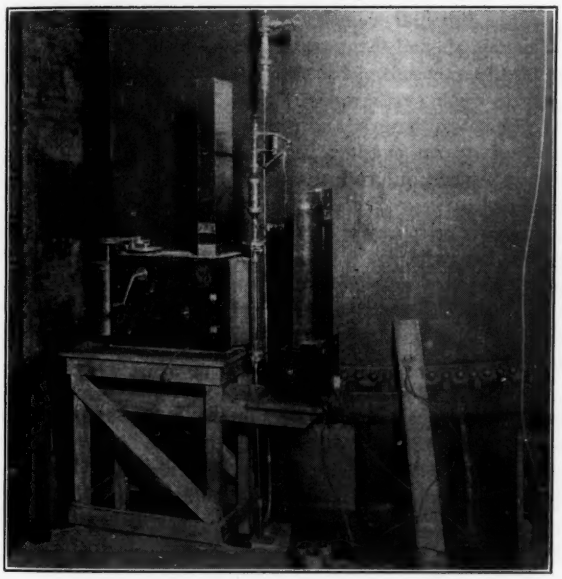


FIG. 4. WHEN SET UP FOR TEST PURPOSES THE EQUIPMENT IS PLACED AS CLOSE TO THE PENSTOCK AS POSSIBLE

Upon the completion of the "pressure-time diagram" or more simply "the diagram," a third signal is given to the observers which terminates the "run," as the operations of the test at each load are called. The unit is then loaded up to the next point desired and everything is placed in readiness for the next run.

These operations are repeated as often and at as many points as are desired. Usually it will be found that from 10 to 12 diagrams ranging from perhaps 30 per cent gate to full load will be sufficient. Each run will require from 10 to 15 min., so that if no difficulties arise, the field work for one unit may be completed in from 2 to 3 hr., exclusive of time required in the preparation for the test and for the leakage test.

Figure 1 is a typical example of a delineated pressure-time diagram. The shaded area represents a measure of the discharge, and is used in the calculation. The quantity leaking through the turbine gates after the shut-down takes place must be determined by a leakage test made on the wheel. Usually this is accomplished by closing the turbine gates and determining the rate of fall of the water surface in the penstock with the headgates closed tight; or in case the latter cannot be closed tight a correction for headgate leakage must be applied.

Without going into a detailed explanation of the delineation and computation involved, it is interesting to note that one diagram may be delineated and computed by one man in one hour so that for a complete test of 12 points on the discharge curve, two experienced men can have the test results in a day's time after the films are developed and blue prints taken.

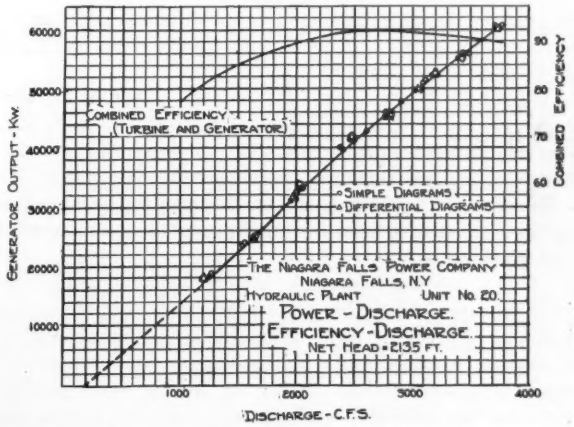


FIG. 5. LITTLE DIFFERENCE CAN BE DETECTED BETWEEN THE TESTS BY THE SIMPLE OR DIFFERENTIAL METHODS

Both applications of the Gibson method were used when testing a 70,000-hp. hydro-electric unit installed in Station 3-C of The Niagara Falls Power Co. and the curve, Fig. 5, drawn to show the two sets of points. The two sets of points gave practically identical results.

In steam power plants the tangible coal pile shows in dollars and cents the value of the most efficient operation of the units installed. Consequently great care has long been taken to install the most efficient machinery obtainable and to find and operate at the point of greatest efficiency. As the demand for power increases and the potential water power sites are being more completely developed, hydro-electric plants are looking more to their operating efficiency with the object of making every cubic foot of water do maximum work.

To get the most power out of the water available it is essential that the operating characteristics of the turbines be known as accurately as possible. The maximum efficiency of various turbines may occur with widely different values of gate opening. Size, type and speed of a wheel and the head under which it operates all affect the efficiency curve. To obtain such curves by an accurate, economical and easily applied method insures a considerable saving to operating organizations by determining the economical point of operation. Furthermore, a check upon the manufacturer's predetermined characteristics is very desirable.

In this day of turbine efficiencies well up in the nineties, any additional improvements devised for the unit can result in only relatively small gains in efficiency. To substantiate the claims or expectations of the contemplated improvements this method of testing has satisfied the demands of accuracy and convenience.

Heat Transmission in Evaporating Apparatus*

RESULTS OF 2 YR. WORK OF YORK MFG. CO., FACTORS AFFECTING HEAT TRANSMISSION IN EVAPORATING APPARATUS, METHODS OF INCREASING HEAT TRANSFER RATES, RESULTS OF ACCURATE TESTS ON SHELL AND TUBE COOLERS AND SPECIAL PIPE COILS. BY THOMAS SHIPLEY†

DURING THE LAST 2 yr. the Research Department of the York Manufacturing Co. has been engaged, among other things, in an investigation to determine the heat transmission through the surface of evaporating apparatus, generally used in refrigerating and ice-making plants.

Since it is our principal object, however, to discover, if possible, a design or a method of operation, or both, which would increase the efficiency and improve the practical operation of refrigerating apparatus, we confined our investigations to the apparatus and the methods generally used for such purposes in commercial installations.

Our first effort was made to determine "The average heat transfer obtainable per square foot of surface, per hour per degree of mean temperature difference, when operating a shell and tube cooler as an evaporating apparatus"—our object being to secure more reliable data on the efficiency and capacity of such apparatus, while being operated under different liquid ammonia heads or levels.

Figure 1 shows a section of the cooler which was used.

This cooler was 34 in. outside diameter by 16 ft. outside of tube heads, and it had 72 2½-in. tubes. The total tube surface was 750 sq. ft. The brine traveled through eight passes. The cooler was provided with a glass gage liquid level device operating with oil, in the usual way. Four sections of this cooler are shown in Fig. 2.

In each of these sections, the level at which the liquid ammonia was held during one of the runs is indicated in inches, from the bottom of the shell.

Table I gives a summary of the conditions under which each of these runs was operated, together with the results obtained.

As a check on the heat transfer and the other variables, we made several series of runs, under different brine temperatures. Table II gives a summary of the results obtained when the entering temperature of the brine was increased from 17.9 deg. to 34 deg.—the cooler being operated under conditions similar to those given in Table I, as to liquid ammonia content and velocity of brine flow.

*Abstract of paper presented at the annual convention of the National Association of Practical Refrigerating Engineers, Kansas City, Mo., Nov. 2-5, 1926.

†General manager, York Manufacturing Co.

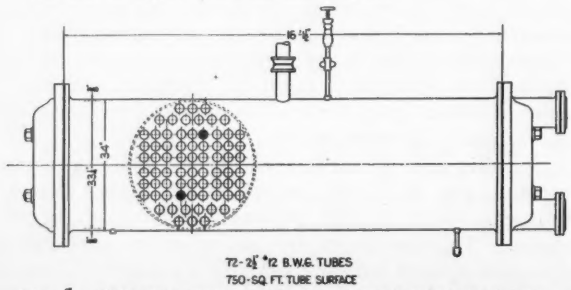


FIG. 1. COOLER USED IN DETERMINING HEAT TRANSFER

The work we had done thus far was only the first step in our investigations—the continuation of which naturally involved the operation of evaporating apparatus with conditions similar to those under which water-tube steam boilers are operated.

This required that we proceed along different lines, for here we must take into consideration not only the velocity of the brine in contact with the outside surface, but also the internal velocity of the gas created by the evaporation of the liquid within the coil rushing toward the suction end of it. This velocity is not only increased as the evaporation is increased, but liquid is spread over the internal surface of the pipe, as long as any of it remains unevaporated.

This internal velocity plays a larger part in the efficiency of such evaporating apparatus than has been generally recognized by many of those who design and operate such systems.

Diameter, length and shape of the piping used in making up an evaporating coil have a material effect on its operation and upon the results which can be obtained.

These and many other questions confronted us as we proceeded with our investigations; however, for our purposes, the only conditions which concerned us were those which directly affected the transmission of heat through the walls of the coils in which the liquid ammonia was evaporated.

Velocity at which the brine passed over the evaporating surface being one of the principal factors which affected the heat transfer, our first consideration was to devise means to increase the brine velocity. This being impossible with open tank construction, we decided to enclose the evaporating system in a casing, through which the brine could be circulated at any desired velocity.

Figure 3 shows three coils which cover the range of design. Each of these coils contains 500 ft. of 1¼-in.

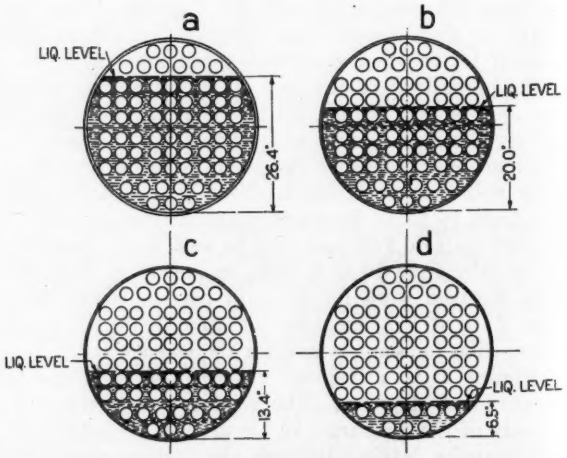


FIG. 2. SECTIONS OF COOLER SHOWING LIQUID LEVELS DURING TEST RUNS

TABLE I. SUMMARY OF CONDITIONS OF TESTS—TABULATION AT 17.9 DEG. BRINE IN

	a	b	c	d
BRINE TEMP. °F. (IN)	17.6	17.9	17.9	17.8
SUCT. PRES. AT COOLER °G.	14.9	13.9	10.6	6.3
DEG. SUPER AT COOLER	3.4	7.3	13.3	23.0
NH_3 TONS	61.4	59.0	51.3	41.0
% TUBE SURFACE BELOW LIQ. LEVEL	87.5	62.5	37.5	12.5
HT. OF NH_3	26.4"	20.0"	13.4"	6.5"
MEAN TEMP. DIFF.	15.5	17.3	22.7	30.6
B.T.U. TRANS./SQ.FT./HR./°M.T.D.	62.5	54.5	36.4	21.5
BRINE VEL. FEET/MIN.	129	131	134	133

TABLE II. CONDITIONS AND RESULTS OF TESTS—TABULATION AT 34 DEG. BRINE IN

	a	b	c	d
BRINE TEMP. °F. (IN)	34.3	34.0	33.9	33.6
SUCT. PRES. AT COOLER °G.	24.6	22.7	18.0	10.5
DEG. SUPER AT COOLER	3.5	7.8	14.5	28.7
NH_3 TONS	79.2	75.5	66.2	49.8
% TUBE SURFACE BELOW LIQ. LEVEL	87.5	62.5	37.5	12.5
HT. OF NH_3	26.4"	20.0"	13.4"	6.5"
MEAN TEMP. DIFF.	19.3	21.3	27.5	38.9
B.T.U. TRANS./SQ.FT./HR./°M.T.D.	68.4	56.8	38.6	20.5
BRINE VEL. FEET/MIN.	133	133	135	133

full weight pipe. Coil A is a continuously wound coil, having a special bend to make it possible to build one pipe on top of another, if needed. It is 20 pipes high and 25 ft. long. Coil C is a coil made up with vertical headers at each end, each run of pipe being the length between the headers—25 ft. It is 20 pipes high and has 20 connections to each header.

Coil D has a double row of runs, 10 pipes high—a total of 20. Each pipe is a separate run and is 25 ft. long. This coil is shaped like a steam heating coil, and has horizontal headers, as shown. The tabulation shown in Fig. 3 gives the summary of the results of a number of runs on each of the coils shown. In these runs, the ammonia liquid was fed into the coils by means of a hand operated expansion valve, and the liquid feed so regulated that the average temperature of the gas leaving the coil showed a superheat of 3 deg. Thus, these coils were operated under the "expanded" method of liquid feed.

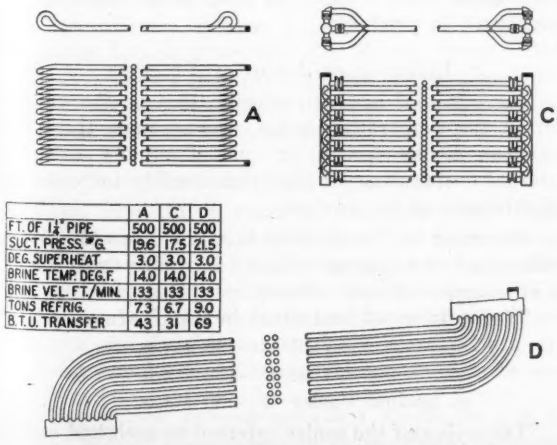
Comparison of the results of the operation of these coils, led us to conclude that long coils are not as effective as short ones, provided the short ones are designed so that the liquid could be fed into them evenly and the discharge end was not restricted. The effect of using vertical versus horizontal headers is shown in the results obtained from coil C and coil D.

Having investigated, sufficiently, the possibilities of coil evaporating systems with brine velocities up to 350 ft. per min., using the liquid ammonia fed into the coil by the expansion method, and having obtained much needed information concerning them, up to the practical limitations of our apparatus, we proceeded to try out the same evaporating systems, under "flooded" liquid feed conditions, and under similar brine velocities, with the following results:

Referring to Fig. 4 coil A is the same as used in Fig. 3. Coil B is coil A split in half; that is, coil A was cut in half, making two sections, which were connected together to make one coil. Our reason for this was to obtain the results using shorter coils of this design. Coil C is the same as used in Fig. 3. Coil D is the same as used in Fig. 3. The table accompanying Fig. 4 gives the results obtained with these coils under the same brine velocity as the runs shown in Fig. 3, and under "flooded" liquid feed conditions.

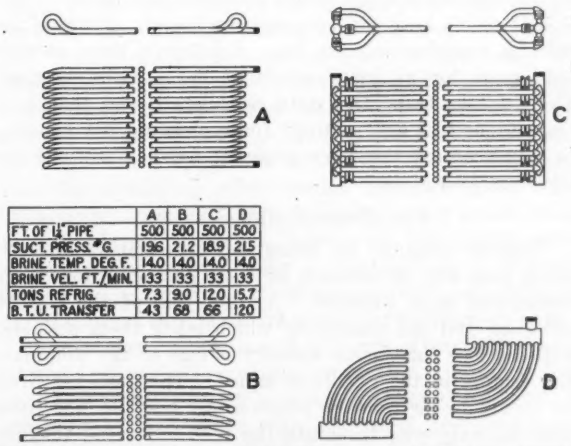
Having obtained the greatest transfer of heat by using short coils, under "flooded liquid feed" conditions, and high brine velocity, we proceeded to check up on the results obtained, by making up two more coils, one following the design of "D" coil, but with 12 runs of pipe instead of 20 and having a total of 137 sq. ft. of surface. This coil, we have marked "E," in Fig. 5.

The second coil was made up, having two horizontal headers, which were connected by short vertical lengths of 1¼-in. pipe. The headers were 3 ft. apart, center to



	A	C	D
FT. OF 1¼" PIPE	500	500	500
SUCT. PRESS. °G.	19.6	17.5	21.5
DEG. SUPERHEAT	3.0	3.0	3.0
BRINE TEMP. DEG. F.	14.0	14.0	14.0
BRINE VEL. FT./MIN.	133	133	133
TONS REFRIG.	7.3	6.7	9.0
B.T.U. TRANSFER	43	31	69

FIG. 3. TYPES OF COILS USED IN INVESTIGATION



	A	B	C	D
FT. OF 1¼" PIPE	500	500	500	500
SUCT. PRESS. °G.	19.6	21.2	18.9	21.5
BRINE TEMP. DEG. F.	14.0	14.0	14.0	14.0
BRINE VEL. FT./MIN.	133	133	133	133
TONS REFRIG.	7.3	9.0	12.0	15.7
B.T.U. TRANSFER	43	68	66	120

FIG. 4. COILS USED UNDER FLOODED LIQUID FEED CONDITIONS

center. This coil was the extreme for short pipe lengths. It also had 137 sq. ft. of surface. We have marked this coil "F."

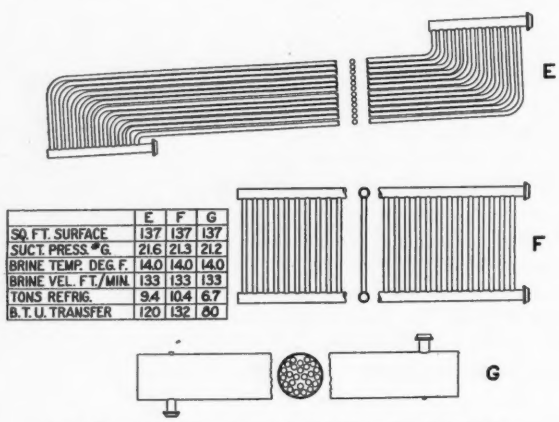
We also built another shell and tube cooler, having the same number of square feet of tube surface (137) as the coils we have described. This cooler we decided to use in our final runs, under the same conditions as these final coils were run. The cooler we have marked "G."

Figure 5 shows the shape of the coils and cooler we used in the final runs of this stage of our investigations.

In the table accompanying Fig. 5 are given the results obtained operating these coils and the cooler under the same conditions, as near as we found possible—"flooded" liquid ammonia feed conditions were maintained during these final runs.

Summary of Results

The cooler runs include cooler operating conditions, in which but 12½ per cent of the tube surface is covered



	E	F	G
SQ. FT. SURFACE	137	137	137
SUCT. PRESS. °G.	21.6	21.3	21.2
BRINE TEMP. DEG. F.	14.0	14.0	14.0
BRINE VEL. FT./MIN.	133	133	133
TONS REFRIG.	9.4	10.4	6.7
B.T.U. TRANSFER	120	132	80

FIG. 5. COILS USED IN CHECKING UP RESULTS

by the liquid, to conditions where the whole surface is covered, as is the case with cooler "G" in our final runs. The transmission of heat obtained in these runs is not at all extraordinary, but they furnish an explanation of the results obtainable under the conditions given. The records of these runs show conclusively that to obtain the best operating results from such apparatus, the shell should be filled, as near as possible, with liquid, for the surface which performs the useful work is that which is in contact with the liquid. There is no gain in superheating the gas. Relatively, these results hold good for all brine velocities for such apparatus. There is one thing this data established, and that is—transmission of heat ratings for coolers do not amount to much unless the percentage of surface covered by liquid is also given.

Coil Evaporating Systems

Results obtained by using coil evaporating systems are a long step in advance of what has heretofore been considered good practice. An analysis of the results obtained and the conditions which made them possible, will disclose that brine velocity is one of the dominating factors in the results obtained. The head required to secure brine velocity removes all possible questions that the only way to obtain the required brine velocity is to encase the evaporating system and treat it as a separate unit. Of course, this eliminates the commonest ice freezing system in use today, which is the system where evaporating coils are set up vertically between the cans.

Another old practice which must be set aside, if we are to take advantage of higher brine velocities, is long coils in freezing tanks. The reason for this is apparent when we take into consideration that increased brine velocity means increased evaporation of liquid within the coils. This, in turn, produces an increased amount of gas, which again, in turn, causes an acceleration in the gas speed within the coil, rubbing the liquid with which it comes into contact against the inner surface of the coils, until the liquid is evaporated or is driven out of the end of the coil.

This accelerated speed of the gas means friction, and it also means increased transmission of heat by reason of the speed at which it rubs the liquid against the inner surface of the coil.

While this action is conducive of better results, where there still remain particles of liquid—as soon as the liquid is all evaporated, the coil becomes a gas passage, wherein no heat is taken up, except the small amount necessary to superheat the gas itself.

The point at which the evaporation ceases, is the point which marks the useful length of the coil, for the conditions under which it is operating.

Thus, the limitation of the useful length of the pipe in a coil, depends upon the rate at which the evaporation takes place within it.

For instance—coil A, Fig. 3, is 500 ft. long. Under a brine velocity of 133 ft. per min., it gave an average transfer of 43 B.t.u. with "expansion" liquid feed conditions and no better results could be obtained under "flooded" feed conditions, but when it was cut in half and made into two sections of 250 ft. each, which, when combined, made up coil B, Fig. 4, a 58 per cent increase was obtained in the transfer of heat (under flooded feed conditions).

Again, coil D with 25-ft. lengths of pipe and the same total feet of pipe, showed a 60 per cent increase under "expansion" feed conditions and increase of 179 per cent under the "flooded" feed conditions.

This we believed to be conclusive evidence that the length of the pipe making up an evaporating system must be governed by its internal diameter and by the work being done within the coil, no matter how the work may be produced.

Internal or Ammonia Velocity

The effect of internal velocity, that is, the velocity within the evaporating space, which causes the liquid ammonia to be spread or rubbed rapidly over the internal evaporating surface, considerably increases the effectiveness of the surface.

Referring to Fig. 5, coils E and F are examples of coils where the internal velocity is rapid, and cooler C is an example of slow velocity.

The transfers of heat given in Fig. 5 are as follows:

Coil E—120 B.t.u.
Coil F—132 B.t.u.
as against Cooler G— 80 B.t.u.

The coils and the cooler referred to each had exactly the same evaporating surface, viz.: 137 sq. ft. and were

operated under exactly the same conditions, when these results were obtained; hence, these data are directly comparable.

We have adopted what we consider a safe rating, which requires 1 ft. of pipe to do the work formerly done by 5 ft. This means a material reduction in the amount of pipe needed to produce a ton of ice and I have hopes that we may be able, this year, to devise means by which we can still further, safely, reduce the surface required in such apparatus.

Thus, you see we do not consider the data I have given you in this paper to be the last word in coil evaporating apparatus, for we have already obtained a transmission of over 180 B.t.u. Therefore, we will not be content very long with our present adoption of 75 B.t.u. for our commercial practice.

Protection of Cold Storage Insulation*

To Prevent the Detrimental Effects of Moisture on Corkboard Insulation, Various Asphalt Products Have Been Developed. By Charles H. Herter†

THIS PAPER is to record the latest methods used in safeguarding cold storage insulation against the entrance of moisture. Corkboard, which is now being employed almost exclusively, has been erected and finished off with Portland cement mortar and plaster for so many years now that this method continues to be specified by those who have not been informed of improvements made in the art.

Manufacturers of corkboard declare that their material is moisture resistant of itself, that it can be boiled for hours and yet remain dry inside; however, in actual use, where the material is exposed to the influence of moisture for months and years, it does lose its insulating value and decays. This applies to all insulating materials, because all depend upon minute air cells for their ability to retard heat flow and, as condensed moisture (water) is denser than air, the air is gradually being crowded out by the water.

Moisture Is Detrimental to Insulation

In the wall of a cold storage room, the corkboard lining is exposed to moisture from both outside and inside. Both brick and mortar are porous and allow moisture to penetrate by capillary attraction, as has often been verified by actual tests. At the room side of the insulation we have this condition: When the door is opened, or if people are present, moisture at relatively high temperature mixes with the air and the goods in the room, such as meat or other perishables, also lose moisture. Very soon the air is fully saturated and whatever moisture is not gathering as frost upon the refrigerating pipes will be precipitated as condensation upon any cold surface or wall.

The detrimental effect of moisture on insulation has been investigated to some extent. In the Insulation Committee Report of the Am. Soc. Refrig. Engrs., 1924, p. 78, it is shown that for each one per cent moisture absorbed the heat conduction increases 4 to 40 per cent, depending upon the material used.

Methods of Protection

When, over thirty years ago, corkboard first came into use, it was being protected against air and moisture by means of waterproof insulating paper on both sides. Also the pure corkboard used to be more dense. The lighter board is a better insulator, but is of course not so strong and durable as the dense board. Formerly the finish for floors, walls and ceilings used to be one or two layers of $\frac{7}{8}$-in. tongued and grooved sheathing, nailed with galvanized nails against furring strips imbedded between the corkboards. The next step was the erection of corkboard in hot asphalt. The exposed face of insulation also might have been mopped over with hot asphalt but this was not done because fire insurance companies prefer a Portland cement plaster finish, at least $\frac{1}{2}$ in. thick, the $\frac{1}{16}$-in. thick coat of asphalt being incapable of withstanding abuse and contact with trucks and packages, although wood fenders might be erected for this purpose.

Insulation asphalt necessarily has to be odorless so as to impart no foreign odor to the products stored. It is difficult to employ hot asphalt in ceiling work, due to hot drippings. The heating of the asphalt by maintaining fires in the building is a nuisance. So the insulation contractors soon avoided the use of asphalt and recommended Portland cement mortar and plaster in nearly all cases. Simple home-made boxes of wood were designed facilitating the rapid coating of cork slabs with a uniform thickness of cement mortar. Thus mortar exclusively was used next to the wall, between courses, and cement plaster finish in two $\frac{1}{4}$-in. coats, applied to the erected insulation.

Moisture in cement mortar occupies a certain amount of space; in due time all this moisture disappears and causes shrinkage cracks. In an effort to hide these cracks plastered surfaces are usually marked off in 3-foot squares or scores, the plaster naturally breaking first in these grooves.

Keep Cork Out of Wet Concrete Forms

In concrete construction, which method came into vogue at the same time, it was deemed good practice and economy to place the ceiling cork right in the forms and to pour the wet mixture on top of it, this being the recommendation of the insulation contractor. It was hoped that the corkboard would bond perfectly and securely with the concrete, and as corkboard had been declared immune against moisture, nobody suspected that the insulating effect would diminish under this method; however, the writer knows of many cases where such corkboard continues to drop off the ceiling, consequently this method must be condemned as unsatisfactory. The rule that insulation should always be kept out of contact with moisture must ever be borne in mind.

The modern protection of all sorts of insulating materials is an asphalt emulsion, equivalent to a pulverized pure asphalt mixed with a certain amount of cold water, prepared in accordance with a process first developed in Germany and covered by a number of United States

*Abstract of paper presented before N. Y. Chapter No. 2, N. A. P. E., March 4, 1927.

†Plant Engineer, Commonwealth Ice Co. and Washington Heights Ice Corp., New York.

patents. Particles of asphalt are held in suspension, together with asbestos fibers, until after the emulsion has been applied on the job, when the water disappears by evaporation, leaving the mixture of asphalt and asbestos fibers behind, in the form of a homogeneous coating. This emulsion can be applied cold with a brush by hand or by means of a spraying machine.

This emulsified asphalt is being marketed under various trade names. There must be differences among these as in the case of other goods of different manufacture, but so far as we can see the main difference is in their water content and consistency. The liquid emulsion flows like cream and can be applied like a paint to metal, stone and wood surfaces with a cheap fiber brush or a spray, while the thick emulsion, or asphalt mortar, simply contains less water. It is plastic and can be troweled on, forming one continuous waterproof sheet, requiring no scoring.

Modern Construction

Approved methods of erecting corkboard insulation will be best understood by describing the various operations required when insulating masonry walls.

In the first place the surface to be insulated must be made as flat as possible because no crevices or hollow spaces can be allowed behind the smooth flat corkboard. Such cavities are apt to hold water of condensation, freezing to ice, which requires more space and thus breaks the bond between cork and surface. Concrete walls may be smooth enough, but other constructions usually require truing up with cement mortar or plaster.

Next apply over the flat wall that has been freed of all dirt and dust, at least one coat of asphalt emulsion for the purpose of filling every pore and providing a base for the asphalted corkboard. Spraying the emulsion on under an air pressure of 50 lb. or more will drive in the asphalt more effectively and cheaper than can be done by hand. Two coats will be better than one. Also the wall need not be dry because the emulsion contains water, while hot asphalt should not be laid direct against any cold wall because it will chill and contract at once, leaving pin holes, and it will not bond well with the wall. The emulsified asphalt also should be kept from freezing during application, and it will flow much better if the air temperature is not below 45 deg. F.

The first course of corkboard is to be erected in a dip coat of hot asphalt, starting this course level and breaking all joints. The second layer is again erected in hot asphalt and preferably secured with wood skewers, breaking joints in both directions.

Asphaltic Plaster

Then comes the surface protection which is very important. Spray or trowel onto the cork surface one thorough application of pure asphalt emulsion, say $\frac{1}{16}$ in. thick, which will completely fill all small holes and cracks. Allow it to dry, then finish with a layer of thick emulsified asphalt mortar a full $\frac{1}{16}$ in. thick, floated to an even surface and then troweled.

Where it is intended to follow up with a white enamel finish, the black asphalt surface can be allowed to toughen up and then be troweled extra smooth by being sprinkled with clean water and again troweled.

After this has thoroughly dried, the entire surface can be given two or three coats of white enamel. If a less expensive coating is desired, aluminum paint may be applied in one coat directly to the black surface, but this is not equal in illuminating effect to the beautiful white enamel. The cost of material for white enamel is about one cent per sq. ft. per coat. The aluminum paint costs about half as much because but one coat is used. These paints stand washing with hot water, insuring a strictly sanitary cold storage room.

Asphalt Paint

The thin creamy asphalt emulsion comes in the proper consistency for painting or spraying and is recommended as a positive protective coating against weather, water, acids, gases, brine and all corrosive substances. It may be used on steel and other metals, on wood, concrete, cement or brick. It is also used for dampproofing masonry, foundations and walls, and for coating prepared and built-up roofings. If it is to be thinned at all, add but a little clean water and always stir well.

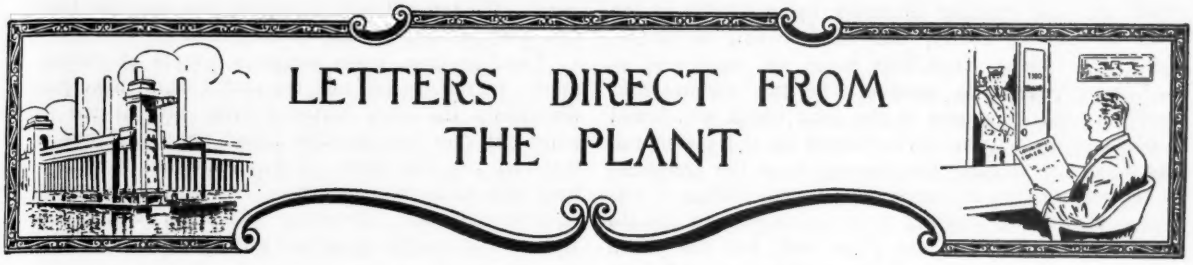
For best results surfaces should be clean and free from all loose particles, oil or grease. Steel brush metal surfaces, whether dry or damp, down to bright metal, but masonry surfaces should be wetted with water before applying. Daub it on thick. Brushes (of white vegetable fiber) should be cleaned with soap and water after using. Do not apply at lower air temperatures than 45 deg. F., and not during rain because it will be washed off. It must be given time to set. With sunshine it will dry in two to three hours. A man will soon learn to give 350 to 400 sq. ft. surface per hour one coat.

Railways Adopt Water-Cement Ratio Law

The American Railway Engineering Association officially adopted a specification for proportioning concrete based on the water-cement ratio law of strength at its annual convention at the Palmer House, Chicago, March 10. This specification was prepared and presented for adoption by the Association's Masonry Committee.

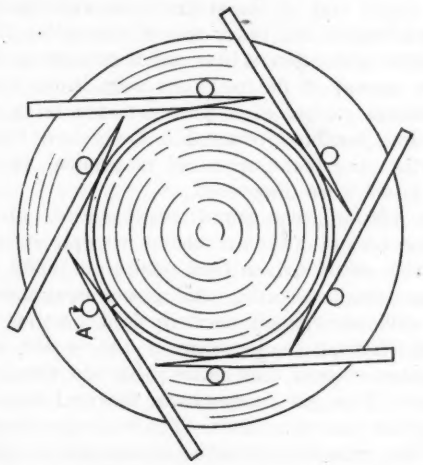
The adoption of this specification by the American Railway Engineering Association marks the abandonment of the 1:2:4 and other arbitrary mixes that have been in use for many years. Instead, the ratio of water to cement is specified, and the proportions of sand and stone are largely left to the discretion of the individual engineer. According to this law, the strength of concrete, within the limits of plastic, workable mixes, is inversely proportional to the amount of water used. By applying this law, engineers can secure concrete of a specified strength within given limits.

Usually the peak load of a generating station comes late or early in the evening when lights are being turned on in offices, stores and homes, and when some industrial plants are still using power to operate machinery. The peak load lasts from 2 to 3 hr., varying with local conditions and, in order to give the service required, it is necessary to install and maintain equipment which is partly idle during the rest of the day.



Replacing Piston Rings

REFERRING to your article in the March 15 issue on "Home made articles are inferior to manufactured," I have used another method, illustrated herewith, for replacing piston rings. This method has been successfully applied to especially large piston rings.



WOODEN WEDGES AID IN REPLACING PISTON RINGS

Ordinary wooden wedges are first sawed out. After placing the ring around the piston and entering the latter as far as possible into the cylinder, one of the wedges is forced between the ring and cylinder head stud at the point which is directly opposite to the joint in the ring, as shown at A. I then drive wedges between each stud and the ring. By tapping these wedges with a hammer as need be, the ring is gradually forced to close until it no longer protrudes at any point above the surface of the piston. It is then a simple matter to push the piston into place.

Buffalo, N. Y. G. J. BOWLES.

Comment on Carpenter's Article

I HAVE READ with considerable interest the article on page 361 in the March 15 issue of Power Plant Engineering by John S. Carpenter, entitled "Engineering Offers Success to Non-College Men." It really contains all that is necessary to enable one to make at least a start on the road to success. If I may, I would like to offer a few comments on some of the points Mr. Carpenter brings out in his article.

It is true, as Mr. Carpenter says, that many young men become discouraged because they have been unable to obtain a college education, but we know that many non-college men have succeeded in various lines of endeavor by using the means at hand and the determination to go on.

While Mr. Carpenter encourages employing home study, correspondence courses, book reading, and the like, by those who have the desire and ambition to succeed, it will be noticed that he does not in the least discount the work of the colleges, nor those who have been fortunate enough to have received such an education and to have applied it wisely and well. The door to success is not closed to those who have not a college education, if they are willing to work and to make some sacrifices, and will follow the advice and suggestions of those who are qualified to point the way.

Further on the article shows what is the "hardest" way to read a book. That is one of the stumbling blocks in the path of the man who is trying to educate himself. There is really no such thing as a self-educated man. All who study must receive some help from others.

Then it goes on to tell how a book should be read to get the most out of it. From personal experience I know that the method given is the best way to study a book.

Correspondence school books are favorably mentioned and well they may be for the persons for whom Mr. Carpenter is writing. I can testify, from 14 yr. experience in this work, as to the care with which these textbooks are prepared and edited.

Not the least important is the suggestion contained in the last paragraph; a lesson in brief on unselfishness which so many of us need.

Brooklyn, N. Y. CHARLES J. MASON.

Overcoming Air Compressor Troubles

THE FOLLOWING is taken from a report, submitted on request, by the writer. The air compressor in question is installed in a neighboring plant. As the service man's report was not in accord with my report, I would be glad to receive suggestions or criticisms from the readers of Power Plant Engineering.

Indicator cards taken from the high pressure side of the air compressor were very good, giving 28.4 m.e.p. on the head end and 33.7 m.e.p. on the crank end. The cards from the high pressure steam cylinder were also good. The air compressor was running, at the time, at 50 r.p.m., doing work at 80 hp. The sound emitted while running indicated something was loose. After taking off the high pressure valve port cover on the crank side, I found the valve to be loose, the clearance being 0.012 in. The valve at the head end was found to have 0.025 in. clearance.

After removing the high pressure cylinder head of the compressor, the piston was found to be much too small. The largest diameter of the piston was found to be 9.974 in. and the largest diameter of the cylinder,

10.035 in., the smallest diameter being 10.023 in. or 0.012 in. out of round, therefore it had to be rebored. The piston rings were much too small and as used were practically useless. The two piston rings used were cut off square at the joint which was found to be open ⅜ in. The screw-thread on the piston rod was too small, causing the connection at the crosshead to be so loose that it hardly held at all. When it was reassembled it was screwed up by hand without the aid of a wrench. The jam nut fitted well, but the piston rod could not have held if the compressor had been working properly.

Recommendations made to the owner were as follows: Obtain the serial number of the air compressor from the name plate and order a new piston rod with an oversize thread so that it may be fitted to the crosshead. Have the piston with its rings made for a 10.023 in. diameter cylinder and assembled complete at the factory with a new head and nuts. The piston rings should have a lap joint or preferably a step joint and the diameter of the new piston head should be 10.019 in.

It may be necessary to do a little scraping on the air cylinder in order to secure a proper fit. The valves and ports should be examined and given attention if necessary.

Two new oversize valves should be purchased and fitted to the cylinder. The one for the crank end should be 2.508 in. diameter, the one for the head end 2.514 in., both being finished off on both ends to fit the compressor.

The above repair work could easily be done on Saturday afternoon or Sunday and thus avoid shutting down during working hours.

Racine, Wis. CARL JENSEN.

The Welcome Salesman

IN A GREAT many power plants the traveling salesmen are not allowed to see the chief engineer except by special permission. Generally speaking, I believe this to be wrong. This restriction indicates narrowness and lack of confidence. Some salesmen may be classed as pests but most of them are selling something that someone needs.

The salesman that I used to welcome most heartily met his death by electrocution while inspecting a boiler. He was an ex-stationary engineer and made his visits such missions of service that I really miss him. On one of his visits he asked me if I was having trouble. I told him about a small favorably known steam trap that had just been installed and which refused to work. After assuring him that I had chosen the correct trap for the job, he asked to see it. I showed him where the trap was. He got down on his hands and knees and opened the trap with a wrench. After assuring himself that the bucket and valve mechanism was all right he closed the trap and tried it. It refused to work correctly and we decided to do nothing further with it.

He surprised me the next morning with an especially early morning call. He walked directly to the place where the trap was installed. "I am sure I know what your trouble is now," he said. "Your steamfitter, in order to save fittings, has set the trap at a slight angle and the hinged bucket and valve mechanism are binding." We immediately remedied this and the trap is now the most dependable in the plant.

Another time, upon seeing a couple of drums of plastic refractory he told me that I could have gotten identically the same material from him at the same price but that the material I had purchased was good material just the same. I was somewhat surprised to hear him make this remark. had been so accustomed to other salesmen "knocking" the other man's product that he had caught me off my guard and had completely won me over.

Moline, Ill. ROBERT ALTHAUS.

Unsuspected Losses Exist in Many Plants

TWO LOSSES of considerable magnitude can be found in many plants, namely, loss of pressure or heat head at the upper end of the steam cycle and rejection of too much heat at the lower end of the cycle. The first loss occurs in the generation and transmission of steam and the second in its use. An acquaintance of mine after taking charge of a plant started on a diligent search for possible preventable losses and though on the surface the plant appeared economical, two unsuspected losses were uncovered.

One 1200-hp. compound condensing engine, four Manning boilers and an economizer, all in excellent shape with steam driven feed pump, air pump and circulating pump, were the total power equipment. The pump exhaust was all used in feed heating, heating from the hotwell temperature of 147 to 198 deg. and then water entered economizer where it was heated to 260 deg. Flue gas temperature dropped from 520 to 396 deg. in the economizer. The boilers were operated at 140 lb. pressure but when an insurance man called at the plant one day he mentioned that the boilers were allowed a pressure of 160 lb. The safety valve springs were immediately changed to carry the maximum pressure which resulted in improved engine economy. He then reversed the position of the feed heater and economizer in the heat cycle. The water was pumped direct from the hotwell into the economizer which increased the heat absorption of the economizer tubes and lowered the flue gas temperature.

High pressure condensate was formerly piped to the hotwell from pipe lines and processes. After a return trap was installed, this condensate entered the boilers at within a few degrees of its original temperature instead of cooling to 148 deg. in the hotwell. This dropped the hotwell temperature to 127 deg. and further improved the economizer performance by dropping flue gas temperature to 330 deg. with a water temperature of 213 deg. leaving the economizer. The steam consumption of the pumps was estimated roughly at 1500 lb. per hour and instead of using the exhaust in the heater the engineer investigated the manufacturing processes that used steam. The gages on the process lines showed close to the boiler pressure and as only one department used steam from a 1½-in. line, the process demand was always considered of no importance, but he figured that even a line of that size if maximum steam velocity of 10,000 ft. per minute were used, could transmit over 2000 lb. of steam per hour allowing for large pressure drop.

He found also that many of the machines had individual control valves throttled so that only 25 lb. pressure existed at point of use. Also the total area of branch pipes was over twice the area of the main. By noting the opening of each control valve several times a day, the approximate steam flow was found to be 2000 lb. per hr. By increasing the size of the main and branches and eliminating all unnecessary fittings and turns, it developed that 25 lb. pressure at point of supply was ample and the exhaust of the pumps was used for that purpose. To raise the feed temperature to the most economical point, the receiver of the engine was tapped for the steam supply to the feed heater. With 15 lb. receiver pressure the feed was heated to 246 deg. This drop from 260 to 246 in final feed temperature does not indicate preventable loss as only 80 per cent of the feed was at this lower temperature, the remaining 20 per cent was at a temperature of about 300 deg. on the return trap system.

The gain made by each individual step was small but the cumulative effect was considerable. The drop in flue gas temperature saved about 2 per cent, increasing the initial pressure at engine gave 3 per cent more available heat and the shorter cutoff with resulting increase in expansions caused an increase in engine efficiency. Bleeding from the receiver, though it increased the flow at the throttle, reduced the amount exhausted from the low pressure cylinder by an amount equal to 50 per cent of the amount bled. With less steam entering condenser the vacuum could be increased by 1 in., thus reducing further the condenser loss. Formerly two separate quantities of steam, 2000 lb. and 1500 lb., were used for process and pumps respectively, but by expanding the process steam through the pumps and exhausting at the pressure and temperature required by the process, the 1500 lb., being no longer needed for pump operation, was saved.

Tabulating the steam consumption before and after each improvement, we can see the exact extent of the saving; the engine steam rate was originally 14 lb.

	Originally	After raising pressure and vacuum	After changing to low process pres.	After bleeding from receiver
Engine	16,800 lb.	15,624 lb.	15,624 lb.	15,924 lb.
Process	2,000	2,000	2,000	2,000
Pumps	1,500	1,500	....	....
Drips	1,000	1,000	1,000	1,000
Total	21,300 lb.	20,124 lb.	18,624 lb.	18,924 lb.

The reduction in engine water rate was estimated by noting drop in the condenser discharge. The amount of bled steam was estimated by noting the increase in feed temperature through heater. Total heat absorbed by feed water in heater divided by latent heat of steam at receiver pressure gives the approximate quantity as 600 lb. Bleeding 600 lb. per hr. necessitates the admission of 300 lb. per hr. more at the throttle while the quantity exhausted to the condenser is 300 lb. less.

The steam consumption of the pumps is considered zero because they exhaust the steam in a dry or slightly superheated condition to the process. As this is a 24-hr. plant the saving of 2376 lb. of steam per hour worth at least 40 cents per thousand pounds amounts to a worthwhile figure.

Springfield, Mass. ANDREW F. SHEEHAN.

Small Oil Cups Made from Old Drain Cocks

RECENTLY in applying some small rods, connections and pins to a feed mechanism, the writer noted that the usual countersunk hole for oiling the connections was not going to afford adequate lubrication for the small pins. They were not large enough to accommodate the average small cup and there would not have been room

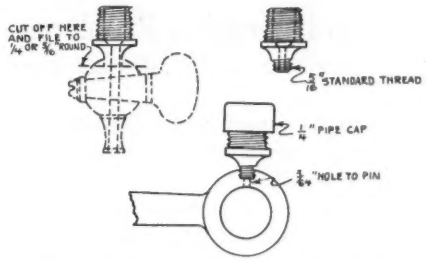


FIG. 1. SHOWING HOW SIMPLY PART OF AN OLD DRAIN COCK MAY BECOME A GOOD OIL CUP

for them, due to location of related parts. Purchase of small cups was not convenient, so necessity required that they be made.

Illustrations herewith show how oil cups were quickly made from old ¼-in. drain cocks. The threaded

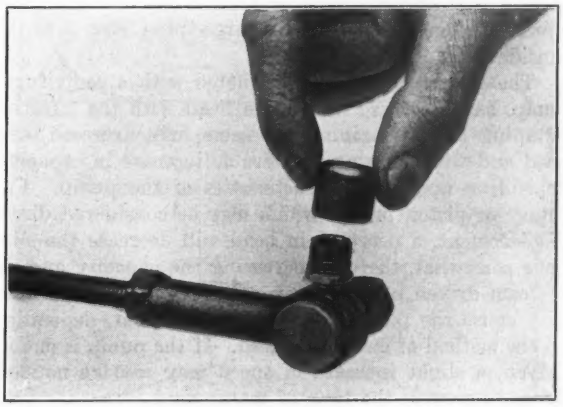
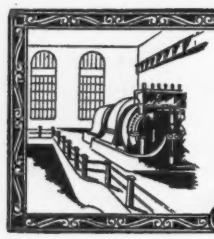


FIG. 2. SHOWING FINISHED OIL CUP AS ASSEMBLED ON ROD

portions of these small cocks were drilled out to at least $\frac{5}{16}$ in. dia. and about ½ in. deep. The body of the cock was sawed off down to the plug hole and filed off below the threaded portion to $\frac{5}{16}$ in. This portion was given three or four threads with a $\frac{5}{16}$-in. standard solid die. The end of the arm was drilled and tapped to this size leaving, of course, the smaller hole for carrying the lubricant to the pin. A ¼-in. pipe cap completed the job. The cups were filled with the usual bit of curled hair. They were quickly and easily made, had the appearance of a "real job" and functioned perfectly.

Missouri Valley, Ia. FRANK W. BENTLEY, JR.

THE BEST method of insuring clean oil at all times is to install an oil circulating system with necessary tanks and filter or purifier. This will prove the cheapest way of handling, storing, inspecting and cleaning lubricants.



QUESTIONS AND ANSWERS

Pump Operation Problems

I SHOULD LIKE to have the following questions answered:

1. How will the capacity of a centrifugal rotary or piston type pump be affected by increasing the pipe size at the discharge?

2. To what extent can a pump suction line be larger than the pump opening and maintain highest efficiency?

3. Is the capacity of a pressure system increased by using a larger line than the opening on the pressure tank? The pressure tank is in the pump discharge line of pressure system and uses compressed air for pressure regulation.

4. Would the answers to these questions be the same for water and oil? R. C. C.

A. 1. If the discharge pipe is a long one and if the greater part of the discharge head is friction head, the effect of increasing the discharge pipe size may be considerable.

The greatest effect will be noted with a centrifugal pump, as a decrease in friction head with the effective pumping head remaining the same, will decrease total head and will cause a considerable increase in capacity, depending upon the characteristics of the pump. For rotary or piston pumps which may be considered direct displacement, a decrease in head will decrease the slippage somewhat, thereby increasing the capacity and, in a steam driven pump, a decrease in the discharge head may cause the pump to speed up somewhat, depending on the method of governing used. If the pump is motor-driven, a slight increase in speed may also be noticed, depending upon the type of motor used.

2. The suction line of a pump can be as large as desired and an increase in size will not decrease the efficiency of the pump. In fact, one might say that the larger the suction pipe, the less the total head the pump will have to pump. If the line is made too small, there will be an excessive friction head which will not only add to the total head of the pump but, if the suction head is very high, will affect the efficiency of a centrifugal pump, although with any type of pump, if the suction lift is set below 15 ft., the efficiency of the pump will not be affected.

3. If, by capacity, you mean the total water contained in the system, increasing the opening on a pressure tank will not increase the capacity, if the entire discharge line is not increased at the same time. It may, however, increase the momentary capacity by decreasing the pressure drop across the opening and allowing the air which is in the tank to force the water out at a faster rate.

4. In general, oil and water have the same characteristics and the results will be approximately the same. The viscosity of oil and water differ considerably, however, and absolute values of the two would not be the same in the same case; that is, the friction in a pipe line with oil is much greater than with water, so that increasing the size of the line would have a tendency to decrease the friction loss more than with water.

Boiler Efficiency Calculations

KINDLY CHECK the following data with the attached calculations of boiler efficiency and give me your opinion of the method used.

Boilers:

Five, class III Stirling; 3920 sq. ft. ht'g. surface. 175 lb. WP. B&W superheaters designed for 90 deg. superheat.

Natural draft.

Fuel:

Natural Gas.

CH_4 = 66.3 per cent
C_2H_6 = 32.4 per cent
N_2 = 1.3 per cent

Heat value = 1290 B.t.u. per cu. ft.

73,400,000 cu. ft. per month.

Feed water:

Zeolite softened then acid treated.

69,910,000 lb. used per month (by Venturi meter)

Temp. 215.5 deg. entering boilers.

TEST DATA

Average feed water temperature

T = 215.5	Steam	press.	176.
32.	Atmos.	press.	14.65
183.5	Abs.	press.	190.65

H = 1197.3

Temp. superheated steam as used = 465

Temp. saturated steam under given conditions = 378

Deg. superheat = 87 at specific heat of 0.604

Factor of evaporation

$$= \frac{1197.3 + (87 \times .604) - 183.5}{970.4} = 1.0975$$

378
215.5

162.5 = Temperature drop on blowdowns

1413 blowdowns at 300 gal. = 423,900 gal.

$$\frac{423{,}900 \times 55.5}{7.48} = 3{,}145{,}000 \text{ total weight of blowdowns}$$

$$\frac{162.5 \times 3{,}145{,}000}{1066.3} = 479{,}500 \text{ lb. loss.}$$

$$69{,}910{,}000 - 479{,}500 = 69{,}430{,}500 \text{ net evaporation}$$

$$\frac{69{,}430{,}500}{1.0975} = 76{,}200{,}000 \text{ equiv. evaporation}$$

$$\frac{76{,}200{,}000 \times 970.4}{73{,}400{,}000 \times 1290} = 78.0 \text{ per cent efficiency}$$

$$\frac{73{,}400{,}000}{76{,}200{,}000} = 0.963 \text{ cu. ft. gas per lb. of water evaporated}$$

$$\frac{76{,}200{,}000}{73{,}400{,}000} = 1.038 \text{ lb. of water per cu. ft gas.}$$

J. A. C.

A. Checking up the total heat of steam at 190 lb. and 87 deg. superheat from the Mollier chart, we find this value to be 1250 and will assume that the remainder of your figures are correct. From this value we are able to check the factor of evaporation which you have and find it to be correct also, although it is not needed in the calculation for boiler efficiency.

In its simplest form boiler efficiency, like every other efficiency, is the ratio of output to input. In this case the units are B.t.u. Subtracting the total weight of blowdown from total weight of the feed water, we find that there were 66,765,000 lb. of steam generated and that the heat supplied to the steam in the boiler is 1250 — 183 or 1067 B.t.u. per lb. The efficiency of the boiler is, therefore,

$$\frac{66{,}765{,}000 \times 1067}{73{,}400{,}000 \times 1290} \text{ or about 75.3 per cent.}$$

If you wish to give the boiler credit for the heat absorbed in the blowdown water it would be necessary to add the quantity $3{,}145{,}000 \times 162\frac{1}{2}$ to the numerator of the efficiency equation given above, which would increase the efficiency to 75.9 per cent.

On the sheet given, the error is made in assuming that the 479,500 lb. blowdown loss is actual water, whereas it is simply the blowdown heat loss equivalent of that many pounds of steam. Therefore, when this quantity is subtracted from the total feed water it gives an evaporation of 2,666,500 lb. more steam than actually produced. If the boiler were fed with 66,910,000 lb. and the blowdown amounts to 3,145,000, it is evident that it is impossible to produce more than 66,765,000 lb. of steam.

As a matter of fact, the net evaporation is 66,765,000 lb. or multiplying by the factor of evaporation an equivalent evaporation of 73,450,000. This would change the last two ratios to practically 1 cu. ft. of gas per lb. of water evaporated from and at 212 deg. or 1 lb. of water evaporated from and at 212 deg. per cu. ft. of gas.

Adjusting for Wear on Crossheads

We have a 34 and 52 by 42-in. cross compound steam engine. The piston on the low pressure side has lowered considerably, showing wear in the cylinder and on the crosshead shoes. We are in doubt whether it was better to adjust the shoes on both crossheads, since this engine has tail rods, thereby suspending the piston above the lower wall of the cylinder, or to open up the cylinder and turn the bull ring, which must have become worn on one side, so as to raise the piston and bring it and the tail rod nearer to the central position. Please let us know which is the better procedure. G. O. S.

A. The principal weight of the piston should be suspended from the crossheads. They and the piston rod have been designed to support this weight since the crossheads may be easily adjusted from time to time and in this way no undue pressure will come upon the stuffing boxes. Tail rods are added to large size cylinders in order to distribute the weight between the two crossheads that are thus made possible. The head end crosshead or the "slipper," as it is generally called, is made lighter in construction than the main crosshead because it carries half of the weight, while the main crosshead takes the thrust due to the angularity of the connecting rod as well as carrying its half of the weight.

It is better to adjust the shoes of the crosshead as soon as any wear is noticed, before this wear becomes excessive.

Faulty Valve Setting

I am operating a 150-hp. cross-compound Fitchburg engine. After repairing the engine, trouble with the speed developed, slowing down when more load is thrown on but not speeding up when the load falls off.

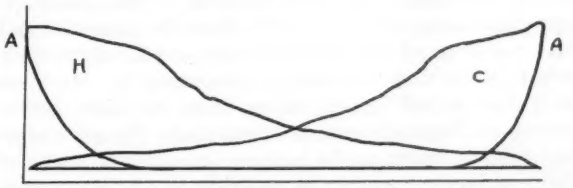


FIG. 1. INDICATOR DIAGRAM FROM HIGH PRESSURE CYLINDER 12¼ IN. × 24 IN., 127 R.P.M., BOILER PRESSURE 92 LB., RECEIVER PRESSURE 8 LB., 80 LB. SPRING

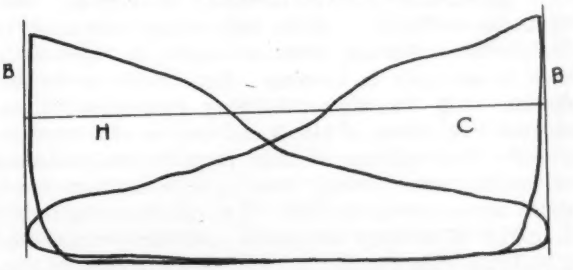


FIG. 2. INDICATOR DIAGRAM FROM LOW PRESSURE CYLINDER 22 IN. × 24 IN., VACUUM 27 IN., 10 LB. SPRING

We put in a new piston and rod on the high pressure side and new crankpins on both sides. We also put in new pins, bushings and springs in the governor. The valves are set for $\frac{1}{16}$-in. lead. What is the trouble? A set of cards taken from the engine is submitted herewith. L. B.

A. Increase the steam lead until the lines at A in Fig. 1 and B in Fig. 2 are perpendicular.

Expand both exhaust valves and make them steam tight. They are now leaking and the engine is not getting proper compression. After this is done, if the engine does not run practically noiselessly, increase the steam lead at both steam valves on the low pressure cylinder until the engine runs smoothly under heaviest load, increasing the lead only sufficiently to balance the engine.

EDITORIAL COMMENT

Fancy and Fact in Power Making

Governor Pinchot has sent a letter to the governors of other states urging their support in the next Congress of government operation of the Muscle Shoals plant and government building and operation of a dam and power plant in Boulder Canyon. Independent engineers who are competent to judge have passed unfavorably on both projects so it is unnecessary to go over that phase of either plan. But it is interesting to compare the fancies of the politician-reformer with the actual facts in the development of the power field.

Mr. Pinchot's imagination conjures a picture of a power ogre, controlling all light and power supplies of the country, charging extortionate prices to the small consumer for his electric current and making life but a drab existence. His scare headline is that the small consumer pays more per kw-hr. than the large one and that the price which the small user pays for a kw-hr. is two to three times the cost of producing it. He gives only two actual figures, taken from his giant power report on Pennsylvania to substantiate his statements but calls attention to the increase in values of stocks of light and power companies as evidence of "dirty work at the crossroads."

Considering first his statements: "A gigantic unified, nation-wide electric monopoly is forming with lightning swiftness." Since high-voltage electricity is dealt with, lightning swiftness might be expected if such a monopoly is forming. But conditions do not disclose such formation. Holding companies for cooperative operation of plants and systems; interconnection for best utilizing of plant capacity and exchange of power in emergencies; financing of local plants which could not otherwise be built. Yes, these are legitimate activities of holding companies and have contributed greatly to wide distribution and cheap supply of electricity, with resulting comfort and convenience to people over large areas. Local plants continue to operate independently, however, where they can do so to better advantage than through a holding company and, where a local plant is taken over, the almost universal result is better service and lower rates.

Chain store operation is a similar development but is not regarded as a menace to the consumer's table even though the householder pays much more for his supplies than does the big hotel or restaurant.

"Stock values have increased." Good! The 3,000,000 owners of securities of light and power companies are receiving the benefit of economical operation in increased returns on their savings, besides the lower rates on the lighting. Stocks go up when returns on them increase. Note General Motors and U. S. Steel. Yet a Chevrolet or a Ford or a steel I beam sells to the consumer for two to three times its factory cost. It is usual to estimate that marketing and distribution cost will equal factory cost on any manufactured article. And for electric current the selling price is regulated in most states by the Public Utilities Commissions, which frown on excessive profits to the power companies.

Mr. Pinchot says: "I am not advocating public ownership." Muscle Shoals *is* government owned and Boulder Canyon will be, if built. Yet it is these two projects, which at best could affect conditions over only a very restricted area, that he wants operated by the government to "safeguard the small consumer of electricity in his *right* to pay no more than it costs to serve him, with a reasonable profit added." The sections to be served by the two projects are remote from large centers and populations. How can they benefit the mass of small consumers? If a threatening gesture is intended, why not make it where a large number of customers will be benefited and big supply affected? Safeguard is now established by commission regulation of rates and as to a "right" to low prices, why not the same right to buy automobiles, refrigerators, washing machines, vacuum cleaners? All add to the "comfort, convenience and cost of living of the average man and woman" for which Mr. Pinchot pleads, but none are necessities.

Another statement, "In most places (effective public) control would mean cutting the small consumer's bill at least in half." How could a plant in Colorado cut in half the bill of a consumer in Philadelphia?

As to facts about the activities of this "ogre," a few figures from an address by Paul S. Clapp, who has for some years been Secretary Hoover's assistant on power developments, hence in position to know whereof he speaks, will be helpful. From 1919 to 1923 the increase in power used in industry was 4,000,000 hp. or 13 per cent, mostly used to make the worker's labor easier and to help increase his production and earning power. Power can be exchanged by the passing along process from Northern Wisconsin to West Virginia and Pennsylvania; from Virginia to Florida; from Idaho to the Mexican Border. Some 2,000,000 hp. were added to generating capacity the last year and for coal-burning stations the fuel per kw-hr. has been practically halved in 6 yr. During 5 yr., 3,600,000 hp. of water power has been developed and put into service, replacing 3,100,000 t. of coal a year in addition to the 11,500,000 t. a year saved by more efficient operation of steam stations. In 7 yr., 1919-1926, households increased their consumption of electricity 133 per cent while industry gained 98 per cent. Result, our electrical output now equals that of the rest of the world. Electricity is used in 16,000,000 American homes and serves 68,000,000 people. During 1926, 1,200,000 new homes were connected to receive electrical service. Small consumers have evidently not become dissatisfied with cost or service.

As to cost, electricity is the only item of family expenditure whose cost is now below pre-war levels; food, rent, clothing, fuel have all shown marked increases. Yet the price of electricity has been reduced to small users as well as to large. Current is available to every city of 5000, to 97 per cent of communities above 1000, to 40 per cent of communities above 250 and to 20 per cent of those under 250 inhabitants.

Could even the fancy of an idealist have visioned such development if he had looked ahead in 1915? Could it have been accomplished by government ownership and operation?

Now fancy, staggered by the facts of accomplishment, seeks to curtail and hamper future development. Why? Public control and regulation is established, the principle admitted by utility companies and results for the most part have been satisfactory. Political fancy needs to go to school to industrial fact if it is to be of service to the country.

Off Duty

On a hot afternoon in June, 1875, in a corner of a noisy machine shop that stood in the narrow streets of Boston not far from Scollay Square, a tall young man was deeply absorbed in the adjustment of a nondescript machine consisting of a clock spring, a reed and a magnet. This young man was Alexander Graham Bell. For over three years he had toiled over this strange device, without result, but on this hot afternoon in June, 1875, for the first time a distinct *twang* had come from the instrument.

In this manner was the telephone born. The story of Bell and his wonderful invention is the most fascinating of anything to be found in fact or fiction and has been retold many times. The almost inaudible sound which Bell heard that afternoon was no more than the gentle twang of a clock spring, but it was the first time in the history of the world that a complete sound had been carried over a wire. Thus in a machine shop, amidst flying belts and whirling pulleys, the baby telephone uttered its first feeble, helpless cry.

That was in 1875. As I write, I have before me the annual report of the American Telephone & Telegraph Co. for the year 1926. Financial reports usually are dry reading, particularly to the non-investor, but in view of what happened on that hot afternoon in Boston fifty-two years ago, this report reads like a romance.

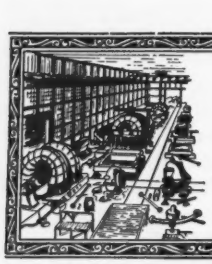
For in it it is stated that today there are in the United States over 17,574,000 telephones. These are connected by over fifty million miles of wire and over them each day 52,354,000 conversations take place! Imagine, 50 million miles of wires—over 2000 times around the world at the equator! It is utterly impossible for us really to comprehend the significance of these staggering figures. Surely, it is a far cry from the first faint twang of Bell's baby telephone in 1875 to the 5998 central offices controlling 52 million daily conversations in 1926. It requires something more than ordinary imagination to conceive of a system of communication having a plant investment of almost two billion, seven hundred millions of dollars, employing over 300,000 workers and owned by over 500,000 stockholders. It speaks eloquently for the soundness of private enterprise in the assertion that each of the 9,790,262 shares of capital stock outstanding earned $11.95 for dividends in 1926 and that for the past 45 years the company and its predecessor have paid quarterly dividends at the rate of at least $7.50 per share per year. Since 1921 it has paid $9.00 per share per year. It is of interest also to know that of this vast organization, whose nerves and transcontinental arteries transmit the life blood of spoken intelligence between 70,000 cities and towns, no stockholder owns as much as one per cent of the total stock outstanding. There is tribute, too, to the constant and effective work of the 300,000 employes who make this system possible in the statement that the average length of time for completing toll calls in 1926 was only two minutes, and that the quality of voice transmission was practically perfect in 88 per cent of the toll calls.

All this has transpired in a brief 50 years. At the Centennial Exposition in Philadelphia, where Bell's telephone was first demonstrated, an astonished world learned that the human voice had been transmitted over a wire strung between one room and another. Several months ago, on January 7, Walter S. Gifford, president of the American Telephone & Telegraph Co., sat before a telephone in the directors' room of the company and in a tone of voice no louder than that necessary to telephone across the street, conversed with Sir G. P. Murray of the British Postoffice in London, three thousand miles across the North Atlantic. Several weeks later, direct commercial telephone communication was opened between San Francisco and London! The latter achievement scarcely received mention in the newspapers.

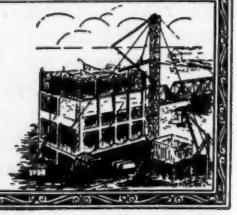
So, step by step, mile by mile, the scientists and engineers of this amazing organization have made this world smaller. London today is no farther from New York, so far as the spoken word is concerned, than Brooklyn was in 1880. Marvel has followed marvel with a rapidity that has made us oblivious to them and has made us take the most amazing discoveries for granted.

But the end is not yet. In the great research laboratories of the A. T. & T. and associated companies, the most expert group of voice specialists and electrical engineers in the world are ceaselessly engaged extending Alexander Bell's invention to greater and greater fields of usefulness. World voice communication is the next move. Already plans are in progress for extending the radio link telephone facilities to continental Europe. From there it is only a step to Bombay, Melbourne and Cape Town. Our telephone of the future will bring us within speaking distance of every square foot of the earth's surface.

In discussing recent European improvements in railway motive power before the Western Society of Engineers, Chicago, Chas. B. Page described the operation of a Ljungstrom type condensing turbine locomotive on the London, Midland & Scottish Railway. He called particular attention to the way in which the design of the fire box and the admission of preheated air had improved combustion conditions, using a rather poor grade of American coal. Mr. Page stated that tests of European turbine locomotives seem to substantiate the claims of inventors to a gain in economy over reciprocating types of locomotives of from 30 to 50 per cent.



POWER PLANT ENGINEERING DEVELOPMENTS AND NEWS



New Metallic Packing for Condenser Tubes

MANY ENGINEERS and condenser users have expressed interest in a new method of packing surface condensers developed by the Crane Packing Co., Chicago, Ill. A patent is now pending for this method,

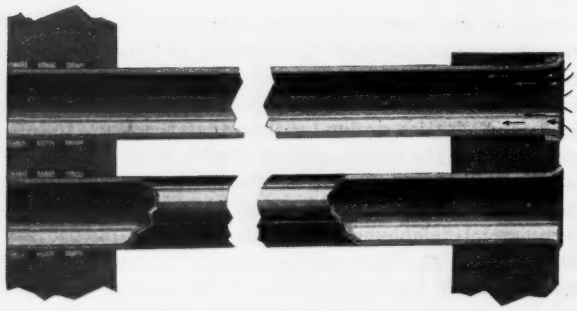


FIG. 1. SECTIONS SHOWING ARRANGEMENT OF NEW PACKING. UPPER—ON CONDENSERS FORMERLY PACKED AT BOTH ENDS, FIBER BUSHING WITH METALLIC BONDING RING PERMITS EXPANDING AND BELLING OF TUBE INLET END. FIBER AND METALLIC PACKING USED ON OUTLET END. BELOW—SAME PACKING AT OUTLET END OF TUBE, THE INLET END OF WHICH IS EXPANDED INTO TUBE SHEET ACCORDING TO RECENT PRACTICE

which permits the use of metallic packing and, at the same time, belling of the inflow end of the tube, which is now generally conceded by engineers to be a great help in preventing the deleterious erosive action that so frequently occurs at this point. The new method makes unnecessary the use of the customary brass ferrule.

This method, when applied to an existing condenser where packing was previously employed at both ends, employs a special metal-insert fiber ferrule, driven into the tube sheet tappings on the inlet ends, as shown in Fig. 1. This bushing, made for a snug driving fit into the threads, is placed on a tapered pin which is inserted into the tube and is then driven into the tube sheet. After this a cylindrical motor-driven expander is employed to slightly enlarge, by expanding, the tube end lying within the fiber bushing, thus producing tightness at the fiber-packed end. Through the use of the special cylindrical rolls and the motor-operated driving machine, this operation of expanding is easily and rapidly accomplished. In fact, experience has taught that one may reasonably expect the average workman to accomplish 200 tube ends an hour.

After the tube ends are expanded, a special drift pin or bell tool is employed to flare the tube ends, which enlarges the entrant ends of the tubes so that they completely close into the annular space in the threaded stuffing-box, affording a retaining means and a protection for the end of the special fiber bushing. The metal slugs in this fiber bushing are designed to connect with the tube and with the tube sheet and to provide a metallic contact between the two.

On the outflow ends of the tubes, metallic packing rings are inserted but, inasmuch as ferrules are not required, owing to the rigid fixation of the tube on the inflow end, these tube sheet drillings may be filled entirely full of packing, thus providing additional packing depth. The combination of packing used on the outlet ends is as follows: first, one fiber ring; second, one metallic ring; third, one fiber ring and fourth, one metallic ring. The set is proportioned to fill entirely

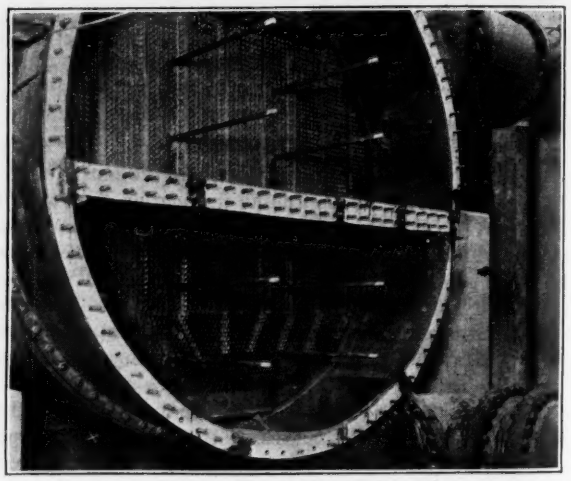


FIG. 2. CONDENSER AT ATLANTIC CITY ELECTRIC CO. IS PACKED BY THE NEW METALLIC PACKING METHOD

the tube sheet drilling to within two threads of the outer face.

This method does not require tubes longer than the flush tube dimensions of the condenser, in order to obtain the funneling effect. Furthermore, tubes of standard hardness specifications are suitable for rolling, as with the rolls and the method of propelling them, as developed, it is not necessary to anneal tube ends before expanding. Either 18 or 16 gage tubes may be employed.

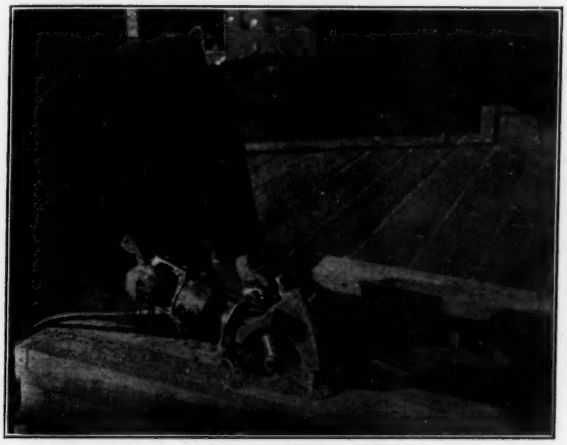
This method also offers an advantage, it is stated, in condensers where the plug method of cleaning is in vogue, as the elimination of the ferrule and flaring of the tube ends make it especially easy to employ the cleaning plugs.

Figure 2 shows a photograph of a large condenser in the plant of the Atlantic City Electric Co., one of the most recent installations of this method.

Light Air-Driven Portable Hand Saw

AN AUTOMATIC portable hand saw, operated by compressed air, has been devised by the Ingersoll-Rand Co. of New York, N. Y. The design combines the Ingersoll-Rand three-cylinder air motor with the Crowe safety saw guard, which is of a telescopic nature, opening when the saw is applied to the material and automatically closing and locking in position as the cut is completed.

By shifting blades the pneumatic hand saw may be used for sawing wood, soap stone, bakelite, wall boards, tin, copper and other materials. Cross cut or rip



THE AUTOMATIC SAFETY GUARD IS A FEATURE OF THE NEW SAW

blades for different types of work are available. Three sizes, taking 6, 8 and 12 in. blades are manufactured and its light weight (the 8-in. size weighs only 23 lb.), makes it possible for the workman to handle and carry about with ease.

New Steam Purifier Is Supplied in Two Styles

DESIGNED TO REMOVE water, dirt and other impurities from steam and vapor generated by boilers and evaporators, the diffuser steam purifier shown in the accompanying illustration has recently been placed on the market by Schutte & Koerting Co., Philadelphia, Pa. The device is new with this company and also new in the United States, although it has previously been marketed in Germany. The purifier is made in two types, internal and external, the internal type being recommended for use under ordinary conditions.

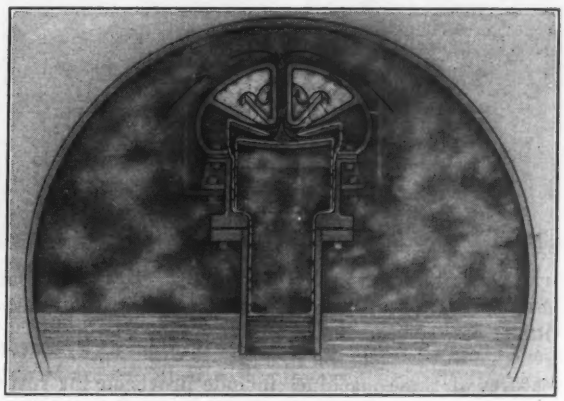
As shown, the internal type of this purifier is installed in the upper part of the boiler drum, supported on hangers attached to the shell. Steam to be purified fills the space in the drum above the water line and enters the purifier from the top through the central passage which runs the entire length of the device. The entrance is rounded to eliminate eddies and pressure losses. Steam flows down to the bottom of this channel where it strikes a horizonal plate that deflects it to right and left into the separating spaces. This arrangement is designed to cause impurities, which are much heavier than the steam, to be thrown both ways along the deflecting plate, and over its edges into the receiver below.

Bottom edges of the vertical inlet passages are rounded to insure smooth flow of steam, which now passes into the diffuser section formed by the slanting separating plates, whose sharp edges are designed to catch any remaining impurities and allow them to drop to the lower plate.

Steam then passes through the diffuser sections into the upper chamber of the purifier, the diffuser sections being designed to act as expanding nozzles and to reduce the velocity of the steam and prevent its carrying along impurities. The steam outlet is connected to the end of the upper chamber and a horizontal pipe and elbow connects the outlet to the boiler steam nozzle.

Impurities draining into the receiver section flow back into the water space through the vertical drain line or can be discharged outside the drum by a discharge pipe (not shown). Where the amounts of steam to be handled are greater than the capacity of the largest single purifier a duplex arrangement can be used. These purifiers are supplied in 3-in. to 7-in. sizes in the single types and in 8, 9 and 10-in. sizes for the double arrangement. In addition to their use in standard boilers, they can also be applied to evaporators handling boiler feed water and other liquids, as well as to oil stills and other industrial apparatus.

In case the usual arrangement inside the boiler drum cannot be obtained, the external type diffuser purifier can be used. This purifier employs the same operating principles as the internal type but is designed to be located outside the shell, handling the steam before it goes to the superheater or to the main steam header. This external type is also adapted for installation in live steam lines to remove moisture, oil or other impurities.



DIFFUSER STEAM PURIFIER, INTERNAL TYPE

Both types of purifiers, together with their methods of installation and sizes, are described in Bulletin 9-P, just issued by the company.

THE ORDER OF THE WHITE LION, an honorary decoration of merit, was presented to Joseph W. Roe, of New York University, at a special meeting of the Masaryk Academy of Prague on March 18, in recognition of his scientific work.

G. E. Co. Builds 94,000-Kw. Tandem-Compound Units

FOR THE Southern California Edison Co., two 94,000-kw., 1500-r.p.m., tandem-compound turbine-generators are being built by the General Electric Co. Each unit consists of a 90,000-kw., 100,000-kv.a. 16,500-v.

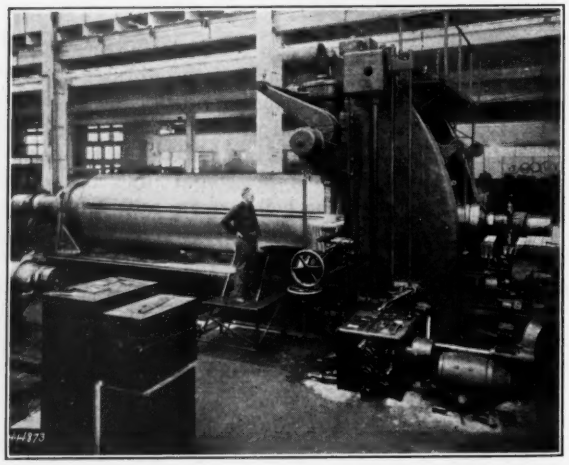


FIG. 1. SLOTTING FIELD OF 90,000-KW. MAIN GENERATOR

main generator, a 4000-kw. auxiliary generator and the 94,000-kw. tandem-compound turbines. Main generators exceed in both capacity and physical dimensions any electric generator previously built; the turbines also are the largest of the tandem-compound type so far constructed. Each turbine-generator will be 103 ft. long and will weigh about 1,650,000 lb. Other unusual

FIG. 2. HIGH PRESSURE SHELL STANDS 10 FT. HIGH ON BORING MILL

FIG. 3. LOW PRESSURE HOOD OF THE HIGH PRESSURE ELEMENT

features of these machines include provision for future gas-cooling of the generators and the combination of a double-flow low-pressure end with four vertical condensers. They will be the first of their type to generate current at 16,500 v.

Figure 1 shows the field of the generator being slotted. Each slot requires 8 hr. for cutting. Two slots are cut at the same time, on opposite sides of the shaft. The field, the largest ever made, weighs 208,000 lb. complete. Figure 2 shows the high-pressure shell of the high pressure element of the turbine. Of one piece, it stands 10 ft. ½ in. high on the boring mill and weighs 82,000 lb. Figure 3 shows the entire low-pressure hood of the high-pressure element of the turbine. The hood is in two parts, with a total height of 24 ft. 7½ in., and a weight of 70,600 lb.

Three Million Dollar Switching Station

WORK will be started soon on the new electric switching station which the Public Service Electric and Gas Co. has planned for the Marion power plant in Jersey City. It will cost approximately $3,000,000, will be called the Hudson switching station and will be the third of this new type of station to be built by the company, the others being at Trenton and Athenia, near Passaic.

This station will distribute electric power generated at Essex, Kearny and Marion generating stations, so as to take care of the growing demands of Jersey City, Union City, Hoboken, Hackensack, Bayonne, Rutherford, Englewood, Edgewater, Leonia and other municipalities in Hudson and Bergen counties. The site comprises about 7 a. in the immediate vicinity of the Marion station.

In this case, a switching station means a plant in which large blocks of power are taken from the generating stations and there redistributed to the various substations in the area to be served, from which substations radiate the circuits serving the individual customers.

That portion of the station to be completed this year will represent a capacity of 168,000 hp. or sufficient to distribute the present output of the Muscle Shoals power plant. The ultimate capacity is designed to be 288,000 hp. or 40 per cent of the total capacity of the electric power plant on both sides of Niagara Falls.

The Hudson switching station will represent the last word in outdoor transformer station construction, the distinguishing feature of which is the almost entire use of copper tubing to form the busses. This permits the weight of the steel supporting the busses to be quite small, or only about 150 t. for the initial part of the station, which will also require about 125,000 lb. of copper busses and cables and nearly 30 mi. of ducts and conduits. The latter will contain the power lines radiating from the station, as well as the wires controlling the operation of the apparatus. The above figures do not include the miles of duct lines to be laid after the power feeders leave the station site.

Another feature of such a large transformer station is the facility with which the power may be cut off in case of accidents, such as short circuits. This is done by means of finely set relays which are influenced by any abnormal condition on the lines. These relays in turn actuate the large oil circuit breakers, which, in a fraction of a second, interrupt the flow of current under a head of oil. Thus breakers weighing 30 t. each are designed to interrupt safely and instantly a flow of power which would be the equivalent of 1,500,000 hp. Each of the six large transformers will weigh 85 t. and will be 28 ft. high. They are furnished by the General Electric Co., while the oil circuit breakers are to be supplied by the Westinghouse Electric & Mfg. Co.

Disconnecting switches and insulators, together with the steel supporting structure, are made by the Railway & Industrial Engineering Co. of Greensburg, Pa., a

subsidiary of the American Brown-Boveri Electric Corp. All equipment, including the foundations, structures and buildings, will be erected by Public Service Production Co. The low and marshy nature of the site of the proposed station will make it necessary to provide a great deal of piling for the safe support of the heavy apparatus and equipment. Much filling-in will also be required.

The first part of the Hudson station is scheduled to go into operation by Oct. 1 of the current year, while the entire first development is expected to be completed early in 1928.

Public Interest in a Power Plant

SINCE the formal opening of the Hudson Avenue station of the Brooklyn Edison Co. on Feb. 2, a steady stream of visitors, at the rate of about 4000 a month, has taken advantage of the opportunity to inspect the station. Great interest has been displayed by the high schools and other educational institutions of this city and, during the past month, many classes have taken this opportunity to see at close range the machinery and operating methods which supply light and power to the greater part of Brooklyn.

The Hudson Avenue visiting list is by no means limited to students of high school and college age, however. Men and women of all ages and from all walks of life, not only from Brooklyn but from other sections of Greater New York and from other cities, have shown sufficient interest in modern methods of power production to respond to the company's generous offer.

Every facility has been provided by the Brooklyn Edison Co. to encourage people to visit its great generating plant. Every week day, busses provided by the company leave from in front of the general office building for the Hudson Avenue station at half-hourly intervals, from 8:30 a. m. to noon, and from 1:30 to 3:50 p. m. An ample staff of competent guides is always on hand at the station during the visiting hours to show visitors around the station and to explain its operation. Many favorable comments on the courtesy and ability of these guides have been received. These men have been detailed to this job from the various departments of the company.

The station is open on Saturday afternoons, the same facilities being provided at this time as during the rest of the week and the company extends a cordial invitation to all its employes to bring their relatives and friends to visit and inspect the station.

New Bailey Meter Co. Acquires General Electric Flow Meter

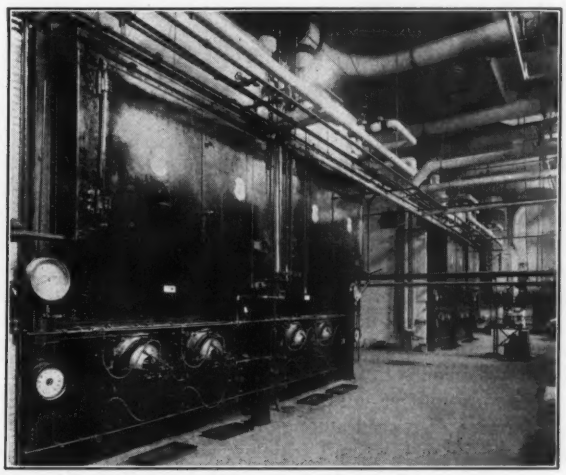
ANNOUNCEMENT is made that a new company has been formed, to be known as the Bailey Meter Co., which on April 1, 1927, acquired the flow meter business and patents of the General Electric Co. and the fluid meter and combustion control business and patents of the former Bailey Meter Co. Payment for the flow meter business and patents will be made to the General Electric Co. in stock of the new company, of which the other principal holder will be the Babcock & Wilcox Co.

Engineering, manufacturing and sales organizations of the former Bailey Meter Co. will be retained by the new company, with the increase in personnel necessary from the General Electric Co. to handle properly the additional business. The new company will have its factory and general offices in Cleveland, Ohio.

E. G. Bailey, president of the former Bailey Meter Co., will be president of the new company. R. S. Coffin, vice president of the former Bailey Meter Co., will be vice president in charge of administration and finances. R. E. Woolley, now connected with the General Electric Co., will be vice president in charge of engineering and sales. The new Bailey Meter Co. will offer its customers a complete line of flow meters, boiler room instruments and combustion control equipment.

New York County Court House Burns Fuel Oil

IN THE ACCOMPANYING illustration is shown the heating plant installed in the new County Court House in New York City. The boiler room contains four Heine water-tube boilers of 3500 sq. ft. heating surface each, fired by fuel oil. This oil, of 14 — 16 deg. Beaumé gravity, is stored in three underground oil storage tanks with a total capacity of 71,000 gal.



EACH 350-HP. BOILER IS SERVED BY TWO OIL BURNERS

Boilers are set in pairs, as shown, and each boiler is served by two Todd mechanical pressure atomizing oil burners with natural draft type air registers. These burners are equipped with automatic air and oil control to maintain constant steam pressure.

Oil is pumped to the burners by three Quimby screw type, electric-driven, high-pressure fuel oil pumps. A duplicate hot water system heats the oil in the storage tanks and three fuel oil heaters are installed between pumps and burners.

THE DELLS PAPER & PULP CO., Eau Claire, Wis., is considering extensions and improvements in its steam power plant. Douglas & Kryster, engineers, of Milwaukee, Wis., have been engaged to make a survey of the situation.

Regional Meeting of A. I. E. E. at Bethlehem, Pa.

ON APRIL 21, 22 and 23, the Middle Eastern District of the American Institute of Electrical Engineers will hold a regional meeting at Bethlehem, Pa., at which technical papers on a wide variety of subjects of particular interest to electrical engineers in industrial plants will be presented. Four technical sections will be held, two on Thursday and two on Friday. A total of ten papers will be presented, all on important subjects of current interest. The session on Friday morning derives added interest from the fact that it deals with the application of electricity to iron and steel production, cement manufacture and anthracite coal mining—the three leading industries of the Lehigh Valley.

All of the technical sessions will be held at the Hotel Bethlehem except the Thursday afternoon session, which will be held in the Alumni Memorial Building on the Lehigh University campus.

On Thursday evening at 7:00 p. m., an informal dinner will be held in the ball room of the Hotel Bethlehem at which the principal speaker will be M. H. Aylesworth, president of the National Broadcasting Co.

A. S. T. M. Committees Report on Investigations

AT THE spring group meeting of the various committees of the American Society for Testing Materials held in Philadelphia March 15 to 18, as previously noted in these columns, the reports of several of the subcommittees were concerned with matters that are often of considerable interest to the power plant engineer and will undoubtedly have an important bearing on the construction and operation of power plant equipment in the future. Brief mention of some of these points will be given below.

The committee on steel, through its various subcommittees, discussed among other things standard specifications for welded and seamless steel pipe which were proposed in addition to those that have been standing as tentative for two years. The committee voted to approve the revisions and will recommend revised specifications for adoption as standards. The results of an extended series of flanging tests of single weld and double weld pipe will be available before the annual meeting of the society.

Several revisions of the present standard specifications for lap welded and seamless steel and lap welded iron boiler tubes are to be recommended for adoption as standard.

The committee approved report of Subcommittee 21 that the two tentative specifications for steel plates of structural quality for forge welding and steel plates of flange quality for forge welding be advanced to standard.

The principal work of Committee A-3 on cast iron was acceptance of a modified arbitration test bar for cast iron to be recommended to the society as a tentative standard. The committee discussed at some length the importance of investigations of impact, wear and fatigue tests of cast iron. Various manufacturers and investigators have arranged a program of fatigue tests.

Committee A-5 on corrosion of iron and steel reported that the atmospheric tests on bare sheet steel, which have been in progress for 10 yr., are still giving results of value at two of the locations. The committee also has in progress tests on various classes of iron and steel to determine their resistance to corrosion in under water service of a sea water, fresh or brackish type.

Committee A-8 on magnetic analysis received reports from various members who are developing apparatus for inspecting steel and steel products by means of magnetic methods. One method of examination, using the cathode ray oscillograph for comparison of material under test with specimens selected as standard, shows promise of being valuable.

Committee C-9 on concrete and the concrete aggregates is sponsoring a symposium on field control of the quality of concrete, which will contain papers on proportioning, mixing, conveying and placing of concrete and other pertinent subjects.

At the meeting of Committee D-5 on coal and coke the sodium-peroxide and bomb-washing methods for the determination of sulphur in coal and coke were recommended as standard methods with the present standard Eschka method. Detailed methods for making screen tests and tests for weight per cubic foot were also presented.

The Joint Research Committee on Effect of Temperature on the Properties of Metals received many reports from co-operating laboratories but final conclusions on the subject will not be available until all the reports have been received and co-ordinated.

National Wealth of the United States

NATIONAL WEALTH of the United States, as estimated by the National Industrial Conference Board, in 1925 amounted to 355.3 billion dollars. This is the first estimate of national wealth published since the census estimate of 1922, which was 320.8 billion dollars for that year. For 1912 the census estimate of wealth was 186.3 billion dollars.

By stating the amounts for 1912 and 1925 in terms of 1913 dollar purchasing value, to eliminate the difference in purchasing value of the dollar and make the two figures comparable, the Conference Board places the national wealth in 1912 at 188 billion dollars and in 1925 at 223.9 billion dollars of 1913 purchasing value. This represents a real increase of 19.1 per cent or nearly one-fifth.

The term national wealth as used in this estimate represents tangible, physical objects only, and excludes credits and currency. Railroads and public utilities represent a total investment of 39.2 billion dollars of physical property.

BY PUBLIC VOTE, the famous Swiss pilgrimage resort of Einsiedeln, Switzerland, has just consented that the enormous water power available in the Sihl basin may be utilized in a hydro-electric power plant to furnish the necessary power for the electrified lines of the Swiss Federal Railroads in eastern Switzerland. Plans for this important station, to be known as Etzel Works, include the construction of an artificial reservoir east of Einsiedeln and the utilization of the falls between this lake and the lake of Zurich.

Construction at Conowingo Progresses Rapidly

IN THE ACCOMPANYING aeroplane photograph is shown the status of the Conowingo hydro-electric development now being carried out on the Susquehanna River, about 2 mi. below the town of Conowingo, Md. This development, which is planned for an ultimate capacity of about 600,000 hp., will be tied in with the four large steam generating plants of the Philadelphia Electric Co. Contract for the design and construction of the dam and power house was awarded to Stone & Webster, Inc., which has sub-contracted the greater portion of the dam construction to Arundel Corp., Baltimore.

CONOWINGO HYDRO-ELECTRIC PROJECT AS IT APPEARS AT PRESENT FROM THE AIR, SHOWING THE POWER HOUSE SITE AT THE LEFT AND A PORTION OF THE DAM AT THE RIGHT

Work was begun on March 8, 1926. The initial portion of the power house will contain seven generating units, each with a capacity of 54,000 hp., giving a total of 378,000 hp., the ultimate capacity to be 594,000 hp. The dam and power house will be located in Maryland but the upper half of the reservoir will be in Pennsylvania.

The lake formed by the dam will be approximately a mile wide at the dam and will extend up the river 14 mi. The Baltimore Pike will be reconstructed and will cross over the top of the dam shortening the distance from Philadelphia to Baltimore by about 15 mi. As the Columbia & Port Deposit branch of the Pennsylvania R.R. will be flooded, it has been necessary to relocate the road.

The dam will be 46,030 ft. long, the power plant 950.5 ft. long and the section containing three regulating gates operated by three 60-t. cranes will be 135 ft. long. A section containing 50 crest gates for relieving flood water is 2250 ft. long and abutment wall section 1190 ft. long. More than 400,000 cu. yd. of rock are to be excavated for the power house and the tail race.

Power will be transmitted from Conowingo to Philadelphia by two 220,000-v. transmission lines.

News Notes

IN NOVEMBER, 1928, a second international Conference on Bituminous Coal will be held at the Carnegie Institute of Technology, according to an announcement by Dr. Thomas S. Baker, president of the institution. "We are so greatly encouraged by the success of the first International Conference on Bituminous Coal held at the Carnegie Institute of Technology last year," he states, "that we have definitely decided to hold a second and similar international congress 2 yr. from now."

The first conference was called by President Baker for the purpose of finding new uses for bituminous coal and especially to discuss the problem of liquefying coal to supplement the petroleum oil supply of the world. More than 1700 delegates, including representatives of 13 different countries, attended. The speakers included Dr. Friedrick Bergius and Professor Franz Fischer, who have successfully liquefied coal; General Georges Patart and Jean Bing, of France; Dr. C. H. Lander, Geoffrey M. Gill, Harald Nielsen, and Dr. R. Lessing, of England; and several other well known foreign scientists.

President Baker stated that the second conference will be planned to uncover whatever new information is made available during the coming 2 yr. regarding various problems in the use of soft coal.

MECHANICAL ENGINEERING DEPT. of Towne Scientific School, University of Pennsylvania, Philadelphia, Pa., announces a new course in fuel engineering beginning September 30, 1927. This course is intended primarily for those who have had the advantage of a complete under-graduate education of college grade and who have also had practical experience in the fields allied to fuel engineering. A degree from a recognized institution is required and, in exceptional cases, in which no degree has been obtained, equivalent qualifications will be necessary. The time required is one academic year in residence at the University of Pennsylvania and upon successful completion of the

course a degree of master of science in fuel engineering will be awarded by the University of Pennsylvania. Full information can be obtained from Dean John Fraser, Towne Scientific School, University of Pennsylvania.

EIGHTH ANNUAL MEETING of the American Welding Society will be held in the U. E. S. Building, 33 W. 39th St., New York City, April 27th to 29th. The program will include reports of committees, a symposium on Research Activities in the Welding Field, and on Production Welding. Also, on the social side, luncheons, a dinner dance and excursions about the city.

AS THE TIME draws near for Oil Power Week, April 15 to 23, the National Committee in charge announces that over 75 meetings have already been arranged and many more are in prospect. These meetings will be held by the local sections of the national technical societies that are particularly interested in Oil Power Week. Everyone interested is welcome to attend the meeting in his locality, whether or not he is a member of a participating society.

Edgar J. Kates, chairman of the National Committee, 29 West 39th St., New York, will be glad to supply the latest information about these meetings.

FOR HOLDING COMMITTEE MEETINGS, the group plan adopted by the American Society for Testing Materials some years ago has proved successful and was continued this year at the regular spring meeting held at the Bellevue-Stratford Hotel, Philadelphia, March 15 to 18. In this meeting 25 committees took part, discussing steel, cast iron, corrosion problems, concrete, electrical materials and the like.

REAFFIRMATION of its determination to continue grade-marking in conformity with the standardization program of Secretary of Commerce Herbert Hoover, together with a new advertising policy and the adoption of a resolution to extend the scope of grading rules governing structural timbers, were the high lights of the Southern Pine Association's 12th annual convention, March 22 to 23, in New Orleans.

ON FEB. 16, the Joint Committee on Invoice Form Simplification adopted a simplified invoice form providing for single or multiple billing which it presents to business houses for adoption when present supplies of bill heads are exhausted. It is the committee's proposal to try this form for 2 yr., then to consider revision according to suggestions and comments which have been received in the meantime. Sample of the form will be sent on request by R. M. Hudson, chief of Division of Simplified Practice, Dept. of Commerce, Washington, D. C.

AUGUST 31 to September 2, a Steel and Power Show will be held in the Varsity Arena, Toronto, Canada, by the Toronto and Montreal chapters of the American Society for Steel Treating, the Canada, Toronto and Hamilton councils of the Universal Craftsmen's Council of Engineers, the Toronto and Hamilton branches of the Engineers' Mutual Benefit Fund and the Toronto branch of the American Electroplaters' Society. Technical sessions dealing with steel treating, machine shop practice and power plant operation will be conducted during the time of the show in the arena. Combined membership of the sponsoring organizations is 1500, and invitations will be sent also to shop and plant executives throughout the provinces of Quebec and Ontario. Details may be secured from C. Bradshaw, general chairman, 143 University Ave., Toronto, 2, Canada.

THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS has accepted the custody of $17,500 given by the Lincoln Electric Co., Cleveland, Ohio, to be awarded under the rules of a competition to those contributing the best three papers disclosing new information that will tend to advance the art of arc welding. Full information concerning this competition may be obtained from Calvin W. Rice, secretary, American Society of Mechanical Engineers, 29 West 39th St., New York City.

THE L. J. WING MFG. CO., New York, has recently appointed C. W. Diemecke as its Chicago representative with headquarters at 549 West Randolph St., Chicago.

THE AMERICAN HAMMERED PISTON RING CO., Baltimore, Md., has added to its sales organization H. W. Marshall, formerly with the Anderson Co. of Gary, Ind.

CELITE PRODUCTS CO., Los Angeles, Calif., announces the appointment of Clyde E. Beckett and Geo. S. Holland to the engineering staff of the concrete department at the Chicago office.

DEARBORN CHEMICAL CO., Chicago, Ill., announces that beginning April 1, its Boston office will be located in Room 908, Charles Chauncy Bldg., 38 Chauncy St., Boston, Mass.

NATIONAL REGULATOR CO., Chicago, Ill., announces that Frank C. Gibbs, formerly with the Chicago office, has been made eastern manager of the company with offices at 166 Lexington Ave., New York City.

HAROLD E. TRENT CO., Philadelphia, Pa., manufacturer of electrically heated industrial equipment, has moved to larger premises at 439-443 No. Twelfth St., Philadelphia.

ACCORDING TO A RECENT ANNOUNCEMENT, the Soapless Lubricating Grease Process, as developed by A. L. Nugey, mechanical and petroleum engineer, New York City, has been taken over exclusively by the Swan-Finch Oil Corp., New York City.

KIELEY & MUELLER, INC., New York City, announces that it is now represented in the Pittsburgh territory by R. S. Eastman Co., sales engineers, 218 First Ave., Pittsburgh, and in the Wisconsin and Michigan territory by Engineering Sales Co., Milwaukee, Wis.

CLIMAX ENGINEERING CO., Clinton, Ia., has recently signed agreements with the Belknap Hardware & Mfg. Co., Louisville, Ky., to handle sales of Climax engines in Kentucky, northern Tennessee, West Virginia and parts of Virginia and North Carolina. Woodward-Wight & Co., New Orleans, La., are dealers in Climax engines for southern Louisiana and southern Mississippi.

ON APRIL 1, Fuller Lehigh Co. took over such of the business of the Bailey Meter Co. as pertains to pulverized coal feeders, burners and water-cooled furnace walls and will also complete contracts for walls and other similar equipment now on order on the same schedule and with practically the same personnel as the Bailey Meter Co.

The sales organization will include E. J. Billings, vice-president in charge, H. G. Barnhurst, H. R. Collins,

A. P. Hachtmann, W. O. Renkin, D. H. Mayo. Branch offices will be operated as follows: Boston, H. H. Leathers; New York, H. B. Jones, C. R. McClure, F. A. Scheffler; Pittsburgh, W. R. Little; Cleveland, L. W. Marso; Chicago, W. E. East, H. D. Lehr; St. Louis, F. C. Brandt; Salt Lake City, W. Z. Harrison; San Francisco, G. C. Barnaby. The engineering staff will include J. B. Gaffney, chief engineer; L. W. Heller, in charge of furnace wall division; A. G. Kinyon, pulverized coal transport; Ralph Galt, chief service engineer; C. A. Maxwell, superintendent of construction; R. M. Hardgrove, research engineer.

MERCO NORDSTROM VALVE CO., San Francisco, Calif., announces that its new factory at Oakland, Calif., to be devoted exclusively to the manufacture of plug valves for various industries, is rapidly nearing completion. The building covers 30,000 sq. ft.

THE BUFFALO, NIAGARA & EASTERN POWER CORP., Buffalo, N. Y., has secured permission to take over and consolidate the Western New York Utilities, Inc.

WM. B. SCAIFE & SONS CO., Oakmont, Pa., announces the 125th anniversary of the establishment of its business and extends to its friends best wishes and assurances of sincere appreciation of cordial business and personal relations.

STOCKHOLDERS OF THE LAWRENCE GAS & ELECTRIC CO., Lawrence, Mass., have been notified that a large majority of the stockholders have accepted the offer of the New England Power Association to acquire the Lawrence company.

THE CENTRAL IOWA POWER & LIGHT CO., Carroll, Ia., has been organized to take over and consolidate the Iowa Light, Heat & Power Co., and the Central Iowa Power & Light Co. The two utilities have been serving more than 200 communities and have a property valuation of about $30,000,000. The new company plans improvements in the present plants and system.

FOR THE MONTH OF FEBRUARY, 1927, the Department of Commerce has issued a report on mechanical stokers. Eleven establishments reported 105 stokers sold under a total of 41,400 b.hp. Of this number 27 stokers were under 3560 hp. of fire tube boilers and 78 stokers were under 37,840 hp. of water tube boilers.

ANNUAL REPORT of the General Electric Co., given out March 30, shows that in 1926 sales billed amounted to $326,974,104, compared with $290,290,166 in 1925, an increase of more than $36,000,000. The best previous high record was in 1924 when sales totaled $299,251,869. Orders received during 1926 amounted to $327,400,207, an increase of 8 per cent over 1925. The previous high record was $318,470,438 in 1920.

Profit available for dividends on the common stock on the 1926 business was $44,314,884, equivalent to $6.14 per share on the 7,211,481 shares of no par value stock outstanding. In August, 1926, four shares of no par value common stock were issued in exchange for each share of the old common stock.

This split-up of shares is reflected in an increase in the number of stockholders from 36,697 in December, 1925, to 46,305 in December, 1926. More than 98 per cent of the stock is held in the United States and nearly half of the stockholders are women. In the report is a statement showing that during the past 12 yr., while commodity prices have advanced 54 per cent and the cost of living has risen 68 per cent, General Electric selling prices have increased but 13 per cent and the average earnings of the company's employes have more than doubled.

M. L. SINDEBAND has been elected a vice president of the American Brown Boveri Electric Corp., according to a recent announcement of that company, and assumed his duties on March 1.

Since 1915 Mr. Sindeband has been in the engineering department of the American Gas & Electric Co. After graduating from Columbia University Mr. Sindeband served with the New York Central Railroad and did station design work with the Brooklyn Edison Co. In 1915 he joined the engineering department of the American Gas & Electric Co. In 1918 he was made electrical engineer and carried on extensive development in transmission line work, carrier current communication, outdoor substations and the like. In this executive engineering work Mr. Sindeband was so successful that he was made a vice president.

Several patents are registered under his name and he has contributed articles and papers to the technical society journals. He is active in the A. I. E. E., New York Electrical Society and N. E. L. A.

Books and Catalogs

"ELEMENTARY STEAM ENGINEERING," by E. E. Lallier; second edition; 288 pages; size 5 by 7½ in.; cloth; price, $2.50; New York City.

According to the author, who is an instructor of engineering in the Hebrew Technical Institute in New York, it is the object of this book to present the fundamentals of steam engineering to those who realize their lack of them. It seems, however, that if this is the purpose, the author could have been somewhat more thorough or at least somewhat more up-to-date.

We learn, for instance, in the opening chapter on heat, that in transfer of heat by radiation the heat is given off in straight lines or rays. This seems to be an extremely ambiguous definition, as it gives no clew as to the character of this radiation or as to the medium in which it takes place. Nothing is said about the ether and no reference is made to its bearing on electro-magnetic phenomena.

In the chapter on boiler operation in discussing scale it is stated that the deposit of solid matter in boilers cannot be prevented and, in the same chapter, we find that, "while hand firing is still continued in many plants, in large plants it is sometimes economical to use automatic stokers."

Referring to the question of pulverized coal, we discover with amazement that the burning of coal has been tried in several ways, principally in the form of briquettes where coal dust is held by a suitable binder of tar or similar material and *also* by blowing a constant stream of dust into the furnace. In discussing methods of boiler feeding it is stated that *occasionally* the condensed steam in the form of water is re-employed as feed water.

Another section of the book which is of interest is that devoted to steam engines. The steam turbine is

classed as a rotary engine. That statement, of course, could be forgiven but, when the author states that "the Curtis turbine is interesting due to the fact of its being a vertical turbine," we lose our accustomed equanimity.

These are only a few of the things which came to our attention in giving the book a casual reading. There are undoubtedly more.

To the reader who desires to know something about modern steam engineering we do not think that this book has very much to offer, since much of the text and many of the illustrations are out of date. To those, however, who wish information on the most elementary principles of engineering, certain chapters of the book may be of value.

APPLICATION OF THE THERMAL CONDUCTIVITY METHOD of CO_2 measurement has been further developed by The Brown Instrument Co., Philadelphia, Pa., through important improvements in the design and construction of the Brown electric CO_2 meter, discussed in a new catalog No. 33, entitled "Brown Electric CO_2 Meters," just issued by the company. One of the improvements consists of combining filter, condenser and cell block in one unit. In addition, a novel construction of combined sampling tube, filter and thermocouple allows the flue gas temperature and gas sample to be obtained through a single opening in the flue wall or uptake. The catalog describes the various types of instruments and may be obtained upon request to the company.

RILEY POWER EQUIPMENT CO., Milwaukee, Wis., is distributing a new 4-page illustrated bulletin describing the Eckenroth automatic reseating blowoff valve. The feature of this valve is that the disc can be rotated on the seat under a definite spring pressure to keep the surfaces true and to prevent leakage. It is made in both straightway and angle types.

GREENE, TWEED & CO., New York City, in a new 56-page booklet entitled "The Door to Economy," describes and illustrates various types of packing made by the company for all types of reciprocating piston rods, centrifugal pump shafts and the like under all conditions of temperatures and pressures. The book also describes the "Favorite" reversible ratchet wrench.

SARCO CO., INC., New York, has issued a pamphlet entitled "The Widening Field of Automatic Temperature Control," a discussion by Joseph A. Maguire, consulting engineer of the company. It discusses the advantages of automatic control and describes many interesting applications in all types of industrial processes.

PERCY PITMAN, turbine maker, London, England, in a catalog issued through G. E. Millner & Co., Ltd., describes a new patent automatic speed regulator for hydraulic turbines. This is designed to give constant speed to impulse turbines and the essential feature of it is the deflector which is installed directly in front of the nozzle. It can be applied to all sizes of impulse-type water turbines.

IN A NEW 16-PAGE, attractively illustrated bulletin, No. 496, No. 4 of the power plant series, Leeds & Northrup Co., Philadelphia, Pa., discusses surface condenser leakage and boiler water concentration. The bulletin takes up, first, various boiler feed water impurities and then discusses chemical and electrical methods of detecting condenser leakage, boiler or evaporator priming and measuring boiler water concentration. The electrical method is advocated by Leeds & Northrup Co. using the alternating current Wheatstone bridge method of determining conductivity. Instruments for this purpose are illustrated and described and the bulletin shows an interesting reproduction of a chart from a conductivity recorder.

THE INTERNATIONAL NICKEL CO., New York City, has issued a Buyers' Guide of nickel alloy steel products listing the makers and fabricators of the various forms of nickel alloy steels and products made from them.

PYREX INDUSTRIAL GLASS PRODUCTS are described and illustrated in a 20-page catalog just issued by Corning Glass Works, Corning, N. Y. This bulletin discusses the physical, chemical and electrical characteristics of the Pyrex products and shows typical examples of these as employed for industrial glassware, electrical equipment, and so on.

L-2033-A AND L-3969-B are the numbers of two new leaflets which have just been released by the Westinghouse Electric and Manufacturing Co. The first one, describing control relays, is a revised leaflet containing the first information printed on the type 30-C and 40-C relays. The second leaflet covers the Type E Oil Circuit-Breakers. Both publications discuss the application, operation and construction of the apparatus and contain several outline drawings and halftone illustrations.

"SOFTENING WATER FOR STEAM BOILERS" is the subject of bulletin No. 670 issued by Cochrane Corp., Philadelphia, Pa. Its 36 pages, which are well illustrated, discuss design of apparatus used in the hot process, comparative advantages of the hot process, zeolite and lime-barium processes, embrittlement of boiler plate, treatment of various types of waters, foaming and priming in boilers, and the like. The discussion includes many points which have recently been the subject of considerable controversy in the engineering field.

SPRAY COOLING SYSTEMS for cooling condensing and circulating water are described in bulletin No. 4-E, a well-illustrated and attractive 24-page bulletin recently issued by Binks Spray Equipment Co., Chicago, Ill. This bulletin shows many interesting views of typical installations of its equipment and contains tables of water ratios and cooling effects, together with details of fittings and blue prints of typical installations. The catalog also calls attention to Binks paint spraying equipment for all industrial applications.

PRESS BULLETIN SERIES No. 7, Illinois Petroleum, will soon be issued by the State Geological Survey at Urbana, Ill. The first paper in this number of Illinois Petroleum gives a brief report on oil possibilities of a structure in southwestern Adams County which recent field work has located.

The second paper summarizes developments in the Illinois oil and gas fields during 1926 and compares them with the results of 1924 and 1925. The prospects of oil and gas production in the state during 1927 are also discussed.

As long as copies are available, they may be secured for 25 cents by addressing the Chief, State Geological Survey, Urbana, Ill.

Sparks from the Advertising Pages

Where Buyers and Sellers Meet

Where the People Rule

Out of the stored-up coal and oil that the Earth yields from bygone ages, we spin the skein of our modern civilization.

In this country, above all others, mechanical power is made available to all the people for all their needs. Here, also, the people have the greatest measure of the material things of life.

At the present time, in many parts of the world, political, industrial and social unrest is evidenced in various forms, and there are numerous alarmists ready to make us believe that some such conditions may arise to affect also the people of this country.

Examine the sources of the superior economic status of the American people and we see that it is built up, stands firm and appears ever to increase through our ability to produce more work per man than that produced in any other country.

Unlike nations that rose to ascendancy and gathered great wealth through conquest, only to fall again through inward decay, the envied wealth of this nation is actively employed in our daily lives.

We are a "going" nation; our wealth is a moving, flowing river of power; and it is becoming more and more controlled by the people not disposed to store up wealth in static forms.

There is now existent in this country a greater participation of all the people in the benefits of wealth than ever before and there is a more general recognition of that fact by all the people.

This national cognizance of economic facts is a self-acting spur to further achievement and an automatic check upon general unrest and any trial of age-old schemes for attaining wealth without work.

The very fact that man by man we each may work with the mechanical power of thirty or more men at our beck and call—that we are each enjoying in no small measure the wealth, comfort and standard of living created by this mechanical power, makes us think differently from the men of all other nations who are not captains of such wealth-producing power.

Perhaps the simplest way of putting it is to say that even the most ignorant man perceives to some extent that he is in business for himself; that when he goes to his day's work he is directly or indirectly the boss of an invisible gang of mechanical workmen.

Men generally feel this, whether or not they are able to talk or write about it. They feel it in the countless ways that they see power working for them.

It is revealed to them in lighted streets and homes, in street cars, autos and railroads, in food from distant points at low prices as compared to their earnings and in every article used in work and play.

Mechanical power is the greatest force in the world to encourage and compel the amalgamation of a people.

Here in America where mechanical power is the mainspring of our mode of living, the driving power of our daily life, it serves likewise to weld every individual's interest into a community of wealth and thought.

Whatever theories or schemes of improvement we may hold, no considerable number of people will, by their own volition or by toleration of others, stop the machinery of life for any considerable time.

No one group can for long hold up other groups without deprivation of the great benefits we all enjoy.

Bound together with rails, wires, mighty drive chains and belts, we must hang together or all fall very shortly into a depth of economic depression that will be felt alike by men and women, whether city or country residents.

Capital, labor, politics can never again succeed in becoming greater than mechanical power. Their squabbles cannot become important enough to stop this mightiest of servants.

In the field of power generation, distribution and utilization there shall ever remain the common interest of the people and the final control of our destinies.

To its further discoveries, applications, developments and economies, every man must look for a higher plane of living for his children and his children's children.

No wars or rumors of war, no strikes, no political propaganda or governing body can long interrupt, destroy or interfere with the onward march of power. For in this all the people will stand as one.

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Under the heading of each product listed will be found the names of the manufacturers of that product. The index to advertisers, next to the back cover, gives the page numbers on which the manufacturers' descriptive advertisements appear.

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